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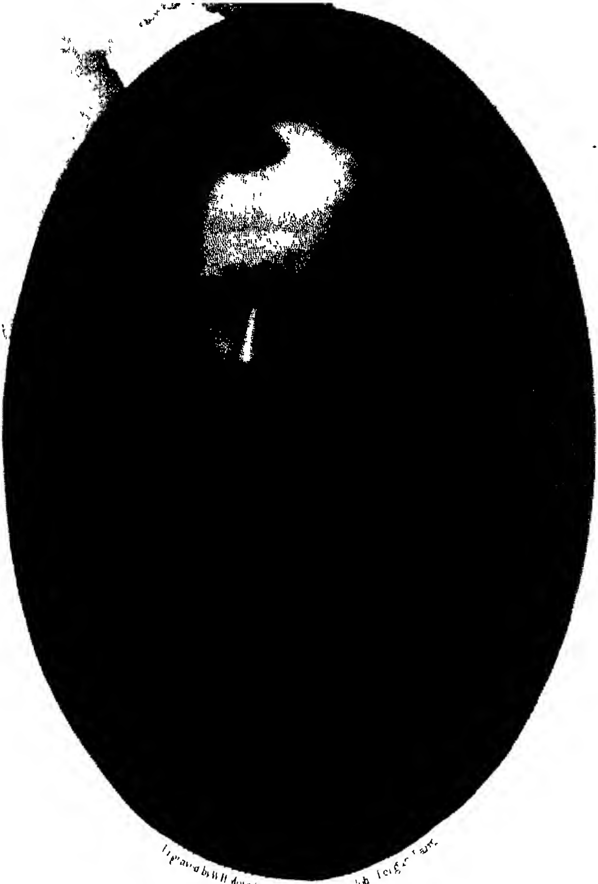


William Thomson

SIR WILLIAM THOMSON F.R.S. LL.D. D.C.L.

President of the British Association 18

THE

YEAR-BOOK OF FACTS

IN

Science and Art

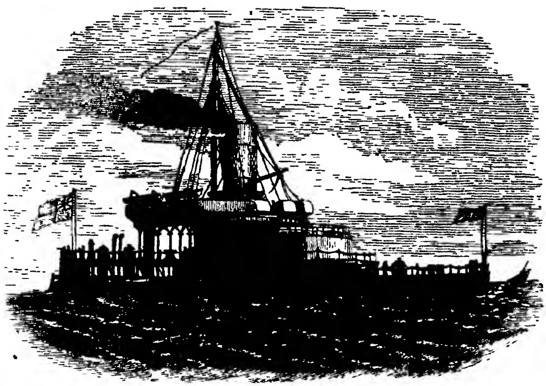
EXHIBITING

THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS OF THE PAST YEAR

IN MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY; ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY AND MINERALOGY; ASTRONOMY AND METEOROLOGY.

By JOHN TIMBS,

AUTHOR OF "CURIOSITIES OF SCIENCE," "THINGS NOT GENERALLY KNOWN," ETC.



The New Iron Turret-ship Glatton. (See p. 9.)

LONDON:

LOCKWOOD & CO., 7 STATIONERS'-HALL COURT.

MDCCCLXXII.

LONDON: PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
AND PARLIAMENT STREET

SIR WILLIAM THOMSON, F.R.S., LL.D., AND D.C.L.

(*With a Portrait.*)

THIS very able investigator of mathematical and physical science occupied the presidential chair of the British Association meeting at Edinburgh in August last.* For his eminent scientific services in the improvement of Submarine Telegraphy, and in connexion with the laying of the Atlantic telegraphic cable, he received in 1866 the honour of knighthood. Sir William was born at Belfast in 1824. His father, Dr. James Thomson, was at that time one of the professors of the Belfast College, but was in 1832 transferred to the Chair of Mathematics in the University of Glasgow, where he became known as the author of an "Elementary Treatise on Algebra, Theoretical and Practical," and an "Introduction to the Differential and Integral Calculus."

William Thomson, educated first at Glasgow, afterwards repaired to Cambridge, since the time of Newton celebrated as the seat of mathematical learning, and entered as a student of St. Peter's College. He graduated in 1845 as second wrangler and first Smith's prizeman, and shortly afterwards he was elected to a Fellowship of St. Peter's. This he held till his marriage in 1852 to Margaret, daughter of Walter Crum, Esq., of Thornliebank. When an undergraduate at Cambridge, Mr Thomson contributed several remarkable papers to the *Cambridge Mathematical Journal*. An article on the "Motion of Heat" was contributed by him in 1842, the author being then in his eighteenth year. In 1845 Mr. Thomson assumed the editorial charge of the *Cambridge Journal*, which from that time was issued on an enlarged basis as the *Cambridge and Dublin Mathematical Journal*. Very many of the editor's earlier and striking communicated scientific inquiries enriched its pages, and the journal became well known to the mathematicians of Europe.

In 1846, at the age of 22, Mr. Thomson succeeded Dr. W. Meikleham as Professor of Natural Philosophy in the University of Glasgow. He next became a Fellow of the Royal Society of Edinburgh, and soon afterwards a Fellow of the Royal Society of London. To the former learned Society he communicated valuable papers on the Dynamical Theory of Heat and Solar Heat. To the latter he has chiefly communicated his researches on Electricity. In 1856, he was presented with the Gold Medal of the Royal Society, for "his various Physical Researches relating to Electricity, to the Motive Power of Heat, and to other subjects;" when the president, Lord Wrottesley, referred to "the zeal with which Professor Thomson was inspired, to his clear apprehension of mathematical and physical truths, and his readiness in communicating his ideas, which has powerfully

* For an Abstract of the President's Inaugural Address, see pp. 262-7.

contributed to stimulate others in the pursuit of truth, and to direct them into right paths."

The Keith Prize of the Royal Society of Edinburgh for the years 1862 and 1863 was awarded to Professor Thomson, when the Vice-President, Sir David Brewster, thus eloquently referred to the valuable papers communicated to the Society's Transactions during 17 years by Professor Thomson:—"These papers, and others elsewhere published, relate principally to the theories of Electricity, Magnetism, and Heat, and evince a genius for the mathematical treatment of physical questions, which has not been surpassed, if equalled, by that of any living philosopher. In studying the mathematical theory of Electricity, he has greatly extended the general theorems demonstrated by our distinguished countryman Mr. Green; and was led to the principle of 'electrical images,' by which he was enabled to solve many problems respecting the distribution of electricity on conductors, which had been regarded as insoluble by the most eminent mathematicians in Europe. In his researches on Thermo-dynamics, Professor Thomson has been equally successful. In his papers 'On the Dynamical Theory of Heat,' he has applied the fundamental propositions of the theory to bodies of all kinds, and he has adduced many curious and important results regarding the specific heats of bodies, which have been completely verified by the accurate experiments of M. Joule. No less important are Professor Thomson's researches on Solar Heat, contained in his remarkable papers 'On the Mechanical Energy of the Solar System;' his researches on the Conservation of Energy, as applied to organic as well as inorganic processes; and his fine theory of the Dissipation of Energy, as given in his paper 'On a Universal Tendency in Nature to the Dissipation of Mechanical Energy.' To these we may add his complete theory of Diamagnetic Action, his investigations relative to the Secular Cooling of our Globe, and the influence of internal heat upon the temperature of its surface."

Sir David Brewster, after referring to other works, added that "the important conclusions which he obtained from 'The Theory of Induction in Submarine Telegraphy,' have found a valuable practical application in the patent instrument for reading and receiving messages, which he so successfully employed in the submarine cable across the Atlantic; and when that great work is completed, his name will be associated with the noblest gift that science ever offered to civilisation. By his delicate electrometer, his electric spark recorder, and his marine and land relation galvanometer, he has provided the world of thought with the finest instruments of observation and research, and the world of action with the means of carrying the messages of commerce and civilisation which have yet to cross the uncabled oceans that separate the families of the earth."

The researches of Professor Thomson in Electricity have been continued through a long series of years. Up to the year 1860,

he had made to the British Association nearly 30 different communications in one branch or other of this department of science. His contribution to the Royal Society in 1855, "On the Theory of the Electric Telegraph," is most important in this respect, that the investigations recorded in it were commenced in consequence of a letter received by the author from Professor Stokes, dated October 16, 1855, and were communicated to the Royal Society before the full development of the mathematical parts were completed, as serving to indicate some important applications of the theory. The inquiry into which Professor Thomson was led by Professor Stokes was, it would appear, the point of transition from his more abstract remarks on Electricity to their practical applications in land and submarine telegraphy, by which he was afterwards to render signal services to the world, and to become more widely and popularly known. The mathematical theory of magnetism, as developed by Poisson, was made to rest on foundations in some respects too speculative. This subject was taken up by Professor Thomson, who, in a lucid and satisfactory manner, placed the theory on the basis of observed facts, so as to render it more independent of any ulterior suppositions which may be adopted respecting the nature of magnetism.

On the sublime subject of Solar Heat, as modified by Professor Thomson, his main contribution to the meteoric theory has been his pointing out that the meteoric supply could not be perennial. In the present state of science, he thinks the most probable is Helmholtz's view, that the sun originally acquired its heat in being built up out of smaller masses falling together, and generating heat by their collision; but that at present it is simply an incandescent mass cooling. In a paper published in 1868, in the *Transactions of the Geological Society of Glasgow*, Sir William Thomson brought his conclusions regarding the amount and duration of the solar heat to bear upon the question of geological time, and found cause to call upon uniformitarian geologists to reform their estimates of the periods assigned by them for past changes on the globe.

Professor Thomson's communication to the Royal Society (Bakerian Lecture, 1856), is entitled "On the Electro-Dynamic Qualities of Metals," and contains the discovery of the electric convection of heat in metals. This paper, with that "On the Rigidity of the Earth," also communicated to the Royal Society, and the series of papers on the "Dynamical Theory of Heat," already referred to, are perhaps the most valuable of Sir William Thomson's contributions to learned societies.

Besides other papers written by Professor Thomson on the Electric Telegraph, he has published an article in the *Encyclopædia Britannica*, describing the instruments invented by himself, and used in laying the Atlantic cable, together with an account of the first expeditions of 1857 and 1858. In August, 1858, the world's news was for the first time read on the same day in

the capitals of Europe and America. As the time for laying down the cable of 1858 approached, difficulties of a formidable character were experienced in the electrical department; and Professor Thomson consented to go out in the *Agamemnon* and occupy the place of acting electrician. After the cable was laid he remained at Valentia, and perfected that wonderful instrument known as Thomson's Galvanometer, which combines extreme delicacy and simplicity of construction, with a large visible range of observation presented to the eye. By this instrument a ray of light reflected from a tiny mirror suspended to a magnet, travels along a scale and indicates the resistance to the passage of the electric current though the cable by the deflection of the magnet, which is marked by the course of this speck of light. If the light of the mirror travels beyond the index or out of bounds, an escape of the current is taking place. From the failure of the cable to communicate in October, 1858, until the great enterprise was finally achieved, Professor Thomson was actively engaged, and both by advice and action exerted himself to perfect the system of telegraphic communication. He accompanied the subsequent expeditions of 1865 and of 1866, and shared in the consummation of the great undertaking.

A recent invention of our ingenious philosopher, the syphon recording instrument, was exhibited for the first time in England at the opening of the British Indian Submarine Telegraph, when the Prince of Wales was present. In virtue of improvements recently made, this instrument is now beginning to supersede the "mirror telegraphic galvanometer."

This beautiful instrument, and other labours of Sir William Thomson, will be found described in the following pages; and it remains for us to acknowledge the valuable aid we have received in this sketch from a very able memoir of Sir William Thomson, which appeared in the *Leisure Hour* for August, 1871.

The prefixed portrait is engraved, by permission, from a photograph, by Mr. John Fergus, Largs.

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Errata.

Page 128, *for* George Biddle, *read* George Biddell Airy.
,, 192, *for* Formia *read* Formica.

THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

"THE GLATTON" TURRET-SHIP.

(See Vignette in Title-page.)

This new iron Turret-ship of low freeboard was designed by Mr. E. J. Reed, the late Chief Constructor of the Navy, not for seagoing service, but for the home defence of our harbours and ports. Her trial-trip off Sheerness was very satisfactory, with respect both to the performance of her engines, and the working of her two huge guns, each weighing 25 tons and throwing a shot or shell of 600 lb., mounted on the gun-carriages of Captain Scott's design.

The shape and look of the *Glatton* seem very uncouth. She is only 3 ft. above the water, and can be reduced, if necessary, to 2 ft. by flooding her water spaces. She draws 19 ft. of water, and the height of her hurricane-deck is nearly 22 ft., so that from top to keel she is barely 40 ft. in depth. Her length is 264 ft., and her breadth 54 ft. She maintains this great breadth almost throughout, broadening out at once both fore and aft like a spoon, which indeed her main-deck resembles, except that it is flat instead of concave. There is no bulwark above the deck, only a single iron chain running around it. The tonnage of the vessel is 2,709 tons; she carries 500 tons of coal. Her engines are of 500-horse power nominal, but can be worked up to 3,000-horse power; they are similar to those of the *Vanguard.*

The Vignette, in the title-page, shows the *Glatton* in her fighting trim, drawing 20 ft., just as she went out upon the recent trial of her gun-carriages. The guns are run out ready for firing when the range is clear and the anchors are stowed at the bows. It will be seen that the first light deck extends from the armoured breastwork 7 ft. high and 120 ft. long, which encloses and protects the base of the turret, funnel, and air passages, right aft to the stern; its width being, however, scarcely more than a third that of the ship's deck proper. Above this a second light or flying deck is shown, surrounded by the nettings, with a hollow box in which the men's beds are kept by day. The mast, which towers above all, is used to hoist up boats or to make signals. There are no sails. The hull is divided vertically into nine water-tight compartments, and horizontally into three flats, the lowest of which is occupied by empty air-tight spaces. The turret revolves by steam in thirty seconds, or by

hand in three minutes. There is a pilot-tower on the hurricane deck, from which the commander, by speaking-tubes or by electric telegraph, can direct the movements of the vessel, communicating with the engine-room, the turret, and the steering-wheel.

The thickness of the plating round the low sides of the *Glatton* is 12 in., running off to 8 in. at her extremities, and to 10 in. at a depth of 4 ft. below the water-line. The whole depth of the armour-belt is 7 ft. The single turret is protected by 12 in. of iron, laid upon a teak backing 16 in. thick, and by an inner skin $2\frac{5}{8}$ in. in thickness. The deck consists of 3 in. of iron under 5 in. of oak. The whole weight of armour carried is over 1,100 tons.

The two gun-carriages were designed by Captain Scott, R.N., and manufactured at Woolwich Arsenal. The 25-ton guns are each rifled with nine grooves, and throw projectiles with studs as bearings to run in the grooves, which give the rotation that enables these long bolts, weighing from 400 lb. to 600 lb., to attain great range and accuracy.

The *Glatton* is intended to be one of the centres of a defensive naval force; one of the floating fortresses around which the unarmoured gun-boats now being constructed in large numbers are to be mustered in case of a hostile attack on our shores. Behind the *Glatton* and other turret-ships the coast-guard armour-clads will form either a powerful reserve, or may, changing front, become an advanced line to repel invasion. These reserve ships carry guns weighing from $6\frac{1}{2}$ tons to $12\frac{1}{2}$ tons, which can throw projectiles from 120 lb. to 260 lb. in weight with a velocity sufficiently great to penetrate nearly all the cuirassed vessels of foreign navies

The *Glatton* is not only armed with her two powerful guns, but with a strong spur protruding under water, for the purpose of ramming an adversary. Her importance can be better estimated when it is borne in mind that the hull of the ship is an impenetrable fortress, with too much flotation to be run over, and too great a strength of armour to be penetrated by any gun as yet mounted in any foreign navy. She is under the command of Captain Lord John Hay. These details are abridged from the *Illustrated London News*, and the Vignette is reduced from one of Mr. Edwin Weedon's admirably drawn illustrations in that popular journal, which also contains engravings of Captain Scott's Gun Carriages.

"THE CERBERUS" STEAMSHIP.

The *Melbourne Argus* gives the following account of an excursion down the bay in September to witness the performance of the *Cerberus*:—"The *Nelson*, the splendid three-decker of the old naval *régime*, which was presented to Victoria by the Imperial Government, and is now used as a training-ship, was prepared for the reception of visitors, and accompanied the

monitor. The day was fine, and a total of 500 persons, including his Excellency the Governor, the Intercolonial Delegates, the hon. members of both Houses of Parliament and their friends, were taken by small steamers to the *Nelson*, which then steamed down the bay, and ample opportunity was given to all on board to watch the operations of the *Cerberus*. She was manned by her ordinary skeleton crew of 18 men, to which were added 60 picked boys (who proved extremely serviceable) from the *Nelson* training-ship, and was commanded by Captain Panter, senior naval officer of Victoria. Her steaming powers were the theme of admiration. Despite the badness of her coals and her foul bottom, the *Cerberus* made 10 knots per hour easily, and actually beat the *Nelson*. Her twin screws enabled her to display wonderful steering powers, and she was not only turned round in her own length, but steamed round the *Nelson*, almost describing a parallelogram as she did so, the angles shown by her wake being so well defined. To show the power of her guns, she brought them to bear upon the little canvas floating target (14 ft. wide at the base and 18 ft. high, moored to a small anchor) at a distance of 3,700 yards. Two shells were then fired from one turret. The first went a little to the right of the target, and fell short, but the second was a splendid shot—a little short, indeed, but directly in the line of the faintly glimmering speck, about two miles off, at which it was aimed. The guns were both loaded with common 400-pounder shell (the *Cerberus* has no solid shot on board), fitted with Boxer's time-fuses, and a reduced charge of 40 lb. of powder. Each shell contained a bursting charge of 27 lb. of powder. It was remarked at this point that some especial cause must be present to prevent the shells from bursting, for out of all the 400-pounder shells fired in Victorian waters only two have been known to burst. At present the theory is that the great concussion of the guns disturbs the operation of the time-fuse. The firing being then over for a while, the *Cerberus* was made to move in relation to the *Nelson*, so as to be able to bring her four guns to bear upon the larger vessel, which in her turn could only bring two guns of her enormous armament to bear upon the monitor. The firing was then recommenced. The first two shots were fired under the same conditions as before, and at the same distance. One, which occupied only 12 seconds in its flight, fell short a little to the left of the target; but the other, which was in the air 13 seconds (the time-fuse was pierced as before for 14 seconds), fell a little distance in front of the target, and was, indeed, admirably aimed. The elevation was scarcely enough for the distance, but that was almost a necessary concomitant of the fact that it was only a small target which was aimed at, and not a ship's side. In the latter case the range could easily be extended. The only two other shots fired were at a range of 2,700 yards. One fell short, but was perfectly in line, and the other, fired from a higher elevation, burst in the air, scattering pieces beyond the target. This was

the only shell which burst during the day. This concluded the day's work of the *Cerberus*, and she forthwith steamed to her anchorage, and her visitors went ashore. Throughout the day she was as steady as a rock, never rolling in the slightest, though during the forenoon the wind blew a little fresh, and caused the spray to dash over her freeboard."

THE NEW STEAM-SHIP, "PESHAWUR."

THE Peninsular and Oriental Company's new screw steam-ship *Peshawur*, commanded by Captain C. A. White, in her official trial at the measured mile in Stokes Bay, under the adverse influence of a strong westerly wind and short confused seas, attained an average mean speed of 13·816 knots per hour, one run being made with the wind in 4 minutes, or 15 knots per hour. The total weight of coals and stores on board was 975 tons, and the vessel's draught of water was 17 ft. 3 in. forward, and 18 ft. 5 in. aft.; steam, 46 lb.; vacuum, 27 inches; revolutions of engines, 61 per minute. The dimensions of the *Peshawur* are as follows:—Length between perpendiculars, 378 ft.; breadth of beam, 42 ft. 9 in.; depth from top of floor to spar deck, 33 ft. 2 in.; register tonnage, 2,103; gross ditto, 3,781. She is fitted with compound engines of 600 horse-power nominal, which indicated 2,962 during the above trial; diameter of cylinders, 62 and 104 inches; length of stroke, 4 ft. 6 in.; heating surface of boilers, 11,720 square feet; fire-grate surface, 316·8 square feet; condensing surface, 6,059 square feet; diameter of screw, 17 ft. 6 in., and 4 ft. 3 in. long, with pitch increasing from 22½ to 24 inches; weight of screw 12½ tons. The *Peshawur* was built by Messrs. Caird and Co., of Greenock, and is a sister ship to the *Khedive*, *Mirzapore*, and *Pekin*, by the same builders, which have been added to the company's fleet during the past year. These vessels are all provided with accommodation for a large number of first and second class passengers, mails, specie, baggage, and over 2,000 tons of cargo, and are fitted with the latest improvements in every department. A large number of the Peninsular and Oriental Company's directors and officials and other scientific gentlemen were on board the *Peshawur*, and her performances gave great satisfaction.

THE NEW SEVEN-POUNDER "STAR SHELL."

THE *Star Shell* for the 7-pounder rifled muzzle-loading "mountain gun" is constructed in the following manner:—A hollow cast-iron cylinder is manufactured, having a small receptacle turned in its base for half a grain of rifle fire-grain powder as a bursting charge, contained in a shalloon bag. A thin disc of iron screws into the cylinder and covers the bursting charge, having an aperture in its centre, through which trains of quick-match are laid, forming instantaneous communication between

the charge chamber and the flame from the fuze (which will be described hereafter), upon the ignition of the composition in the latter. The half of the shell nearest to the base is considerably stouter in its substance than the upper half, and just admits of six magnesium starlights being placed upright within it, upon the disc covering the powder chamber, so as to leave a small space in the centre of the circle formed by them, exactly over the hole in the disc. The lights are composed of nitrate of baryta, chlorate of potash, magnesium powder, and boiled oil, and are contained in paper cylinders having a small quantity of damp powder at either end. To insure ignition they are surrounded with bands of quickmatch. They are calculated to burn for 14 seconds. The upper half of the shell has seven signal starlights within it, placed upright upon the tops of those below. Their ingredients are nitre, sulphur, orpiment, and magnesium powder slightly coated with paraffin, and their cases are encircled, like those of the magnesium lights, with quickmatch. They are calculated to burn for 35 seconds. Upon the summit of the cast-iron cylinder is a conical tin top, with a wooden stuffing inside holding the brass fuze-box. The ordinary time-fuze will be employed. This, when ignited, after a stated interval darts a jet of flame from the pellet of fuze composition contained within it through an opening in the bottom of the fuze-box, which communicates with the quickmatch leading to the charge chamber at the base of the shell, as well as with that encircling the magnesium and signal lights, thus firing the charge. Hence, when the summit of the shell has been blown off by the explosion of the bursting charge, the starlights are disengaged in a state of ignition. Each series of lights is firmly bound together with string before being placed within the shell. The magnesium lights will be used to throw a strong glare upon an enemy's working parties at night, if required, the others for purpose of signalling at the same time to an adjacent post.

LIFE-PRESERVING MATTRESSES.

Rear-Admiral A. P. Ryder has submitted to the Admiralty that mattresses stuffed with granulated cork, such as are occasionally in use in passenger ships, might be substituted for hair mattresses in Her Majesty's Service with considerable advantage, not only on account of their great buoyancy, but even owing to their economy in first cost. The horsehair mattresses have no permanent buoyancy. A mattress made with rib pieces and stuffed with 11 lb. of granulated cork will float an iron weight of 60 lb., and the buoyancy has been found to be very slightly diminished after twenty-four hours' immersion. The horse-hair mattress sinks in a few minutes with a 60 lb. weight. The cork mattresses would float three men with their clothes on, with their collarbones just above water; one man, if alone, would be floated with his arms, shoulders, and chest above water.

If two hammocks are lashed or toggled together, either before or after the men are in the water, the latter can float between them with an arm over each hammock; and the two hammocks can be steered by the hands while the raft is propelled by the feet away from the sinking ship. Ordinarily there would be only two men to two hammocks; but six men, if they are self-possessed and have been exercised in "hammock-floating drill," could be supported by two hammocks. A man inside the circle of his hammock (the two ends being toggled together), seeing no immediate prospect of assistance, could easily cut the nettles of the two clews and knot the nettles together so as to make a long meshed net, with the ends of the laniards secured to each side of his hammock raft; and, sitting in this net with his chest out of water, he could not sink. Now that the cork is granulated by machinery, and with rib pieces inserved to prevent the cork moving, the mattresses are found quite comfortable to sleep upon. They are supplied to the Russian Navy, and nearly the whole of a frigate ship's company was recently saved by their means after a collision. It has been stated by an officer of rank, who was in the *Bombay* when she was burnt off Montevideo a few years ago, and above 100 marines and many boys were drowned, that all the ship's company might have been saved by the hammocks if these had been buoyant. These cork mattresses might save life not only in case of shipwreck or danger of sinking from collision, but also in time of war, in the event of a ship being rammed, or being injured by shot, shell, or torpedoes. The lives of British men-of-war seamen are very valuable at such a time. But if the question of expense is to be raised, it is to be observed that at present the cork are not half the price of the horsehair mattresses.—*Times.*

THE LIME IN THE MORTAR.

The Rev. Canon Kingsley says, Lime is a metal called by chemists "calcium," but it is never found in that form in nature. It is found in a rocky or chalk form. In its natural state it makes excellent building-stone; and the finest white marble of Italy is carbonate of lime. But, to make mortar, it must be first softened and then hardened. The discovery of mortar was probably a very ancient one, and, like most of the old discoveries, it has probably been made in the East, and gradually spread West. This theory is supported by the fact that the early Egyptian and Roman buildings were made without mortar, although the Romans had plenty of lime at hand. If limestone is roasted in a kiln, carbonic acid gas is given off. We find this out for ourselves, if we stand at the mouth of a lime-kiln, and many a poor tramp has found it out when too late. While in the kiln it also gives off water. Water is locked up in lime, as it is in granite, and in most of the precious stones. When the water has been given off the limestone, it is then waterless oxide

of lime, and that is what we call quick-lime, which will burn and blister like an acid. To make mortar that has to be turned into coarse rough limestone, it has, first of all, to have water thrown on it; and, strange to say, the colder the water, the more of it the lime can drink in. It drinks in the carbonic acid from water and air; and then it is mixed with sand, to make it hard. Mortar does not harden all at once; for we are told that mortar in a thick wall will take years to harden; and good mortar will acquire extreme hardness with age. Passing on to notice the formation of limestone, Professor Kingley said that the more ancient the limestone the harder it is, except in cases where the violent pressure of an earthquake has caused it to harden in more recent strata. He then takes his hearers, in imagination, to an island in the tropical seas; and having got them inside the breakers which surrounds the island, he directs their attention to the coral which lies at the bottom of the shallow water.—*Abridged from the Builder.*

NITROGEN AND MANURE.

MR. LAWSON and D. J. H. Gilbert have contributed to the *Chemical News* of May 26, 1871, a note on the absorption and disappearance of Nitrogen supplied to the soil in the shape of Manure. Their experiments, extended over twenty years, prove that, especially in the case of graminaceous crops, nitrogen supplied to the soil in the form of ammonia salts, remains unrecovered in the increase of produce obtained to the extent of more than half its amount; whilst, if the application of manure were discontinued, but a small proportion of the missing nitrogen would be received by the succeeding crops. At first they were disposed to consider with Drs. Saussure, Daubeny, and Draper that the mystery might be explained by reference to the evolution of the gas from the leaves during the growth of plants. This view they have subsequently found to be erroneous, and that plants do not evolve nitrogen. The conclusions to which their experiments now bring them are, that there is a considerable accumulation within the soil of nitrogen which has been supplied in manure, and not recovered by the crop, but converted into various forms in which vegetation can no longer assimilate it, and beyond this amount of fixed nitrogen, a very considerable amount passes off with the rainfall into the drains and lower strata. They are now directing their attention at Rothamsted to such evidence as is at their command relating to the proportion of drainage to rainfall, with a view to discover the best modes and the best seasons for the application of nitrogenous manures.

STUPENDOUS ARMOUR-PLATES.

MESSRS. CAMMELL AND Co., of the Cyclops Works, Sheffield, have succeeded in rolling, without the slightest defect, the largest armour-plates ever made. The plates are intended to protect the

turrets of the great warship *Devastation*, which is being built at Portsmouth. Each plate weighs 24 tons, and measures 20 feet in length, 9 feet in breadth, and 8 inches in thickness. The time occupied in rolling one of these plates and bending it to the required form was under two hours.

PHOSPHORIC BRONZE.

M. DUMAS has presented to the Academy of Sciences an interesting memoir on Phosphoric Bronze, which has latterly been recommended as one of the best materials for the manufacture of guns and other objects exposed to severe strains. In ordinary bronze the cohesive strength of the metal is much reduced by the oxidation of the tin, though this action is sought to be reduced by the use of wooden rabbles. The oxide of tin, which has no strength in itself, by its interposition between the metallic particles reduces the cohering surfaces, and, consequently, the strength of the metal, in much the same way in which the strength of wrought iron is reduced by burning, which involves the deposition of particles of oxide. By the addition of ½ per cent. of phosphorus to bronze the colour becomes more like that of gold, the fracture approximates to that of steel, the elasticity is increased, and the strength under a fixed strain is doubled. The density and hardness are increased, and some alloys resist the file. But the fluidity when the metal is cast is increased, and finer castings are thus obtainable than in common bronze. By increasing the quantity of phosphorus the qualities of the metal may be changed. A phosphate of tin appears to be formed, containing one equivalent of phosphorus and nine of tin. Guns formed of phosphoric bronze are found to be much stronger than those formed of common bronze; and pinions for rolling-mills, hydraulic cylinders, and other objects exposed to great strains may be formed of it with advantage.—*Mr. Bourne: Illustrated London News.*

THE IRON MANUFACTURE.

MR. B. SAMUELSON, M.P., and M. Inst. C.E., in a very interesting account of Two Blast Furnaces, recently erected by him at Newport, Middlesbro', recently read by him to the Institution, has commented at considerable length on the extraordinary increase in the production of crude iron during the past forty years, which at this moment is four times as large as in 1840. He then proved that since 1750 the iron produced in the United Kingdom had increased three-hundred fold, and stated that at that period the whole annual produce was only equal to two-thirds of that of our modern blast furnace.

The above valuable paper has appeared *in extenso* in the *Mechanics' Magazine*, May 26, 1871.

RAILWAYS IN INDIA.

General Strachey, R.E., Inspecting Officer of Railways tc the Indian Government, has detailed to the British Association certain Facts which he had observed on the Festiniog and other narrow Railways in India and elsewhere, and expressed his entire concurrence with Mr. Fairlie as regards the economy and capacity of the narrow gauge. He said that India was, as compared with England, a poor and an extensive country, requiring very long lines of railway, on which there could as yet be only limited traffic. They were, therefore, compelled to construct them in the cheapest manner compatible with efficiency, and the narrow gauge must, at no distant time, become the type of construction in India.

THE MONT CENIS RAILWAY.

The completion of this gigantic work of engineering science was the crowning triumph of the year 1870, and was only completed just before its close. It is eight miles long and has taken just twelve years to complete, both ends being tunnelled at one and the same time to a central point. This point was reached on Christmas-day, the two ends of the headings having met with perfect accuracy, reflecting the highest credit on the engineers. Owing to the Fact that several thousand feet of rock lay interposed between the tunnel and the surface of the mountain above, it was impossible to sink vertical shafts. Air for ventilation and for working the machines was therefore supplied from each end, the aid of hydraulic power being also called into requisition. In fact, the most complete system of working that could be devised was adopted, and the most perfect machinery was employed. The tunnel is 26 ft. 3 in. wide and 19 ft. 9 in. high ,and will be laid with a double line of rails. The excavations were for nearly two-thirds of the distance through schist, the remainder being through limestone and very hard quartz, causing great trouble and occupying a long time. The compressed air worked the excavating machines, to which it was conveyed by strong 8 in. iron pipes. The excavating machine took out a drift 12 ft. wide by 8 ft. high ; the remainder of the work was executed by blasting, or hand-labour in the ordinary methods. The boring machine was mounted upon wheels, and was forwarded upon a tramway. It had ten perforators, acted upon by two flexible tubes, the one conveying compressed air, and the other water. Each jumper made its own hole, and had a rapid to-and-fro motion, and change of angle by the action of the power applied. The jumpers only bored for blasting, and, when the rock was ready, the boring machine was withdrawn, secured behind folding-doors, and the fuse was lighted. A blast of compressed air was then sent in to clear the smoke and sweeten the tunnel, and the miners proceeded to finish, with their picks, what the boring machine had begun for them. The completion of this tunnel is not only the crowning event of the year, but the tunnel itself is one of the greatest engineering works ever

executed.—*Mechanics' Magazine.* See also *Year-Book of Facts*, 1871, p. 105.

FACTS AND FIGURES ABOUT THE MONT CENIS TUNNEL.

THIS tunnel completes the continuous rail line of the same gauge, from the English Channel to Brindisi, in the south of Italy, 1,890 miles in length, which latter point is even now the great Mediterranean port for the departure and arrival of steamships for the East via Suez Canal.

Mont Cenis lies between "St. Jean de Maurienne," in Savoy, and "Susa," in Piedmont, consisting of a high table-land 7,000 ft. high, rising abruptly to a peak nearly 12,000 ft. high. The First Napoleon built a road 10 ft. wide over this mountain, costing 7,000,000 francs. Then followed the railway with three rails in 1867, which has had fearful snows and heavy gradients to contend with, and being of narrow gauge, has been only of temporary benefit.

The tunnel was commenced in 1857, and work has been unceasing day and night ever since. Its length is 7 miles 1,020 yds. "Bardonneche" is the name of the Italian end, while the French terminus is called "Fourneaux." The Italian end is 4,380 ft. above the level of the sea, the French end being elevated 3,946 ft. The tunnel grade-line is 1 in 2,800, rising from the Italian end to about the centre, then falling 1 in 45 to the French end.

The rock passed through seems to have been schist, quartz, and limestone. Commencing at the French end, there was schist for about 2,400 yds.—average progress, 4 ft. per day; then 550 yds of quartz—average progress, 2 ft. per day; then limestone for about 3,000 yds.—average progress, 7 ft. per day; the balance of the distance being principally schist, with an average progress of 5 ft. per day.

The tunnel is 25 ft. wide and 24 ft. high, and during the prosecution of the work was divided by a temporary wooden flooring into two galleries—one above the other below—bad air passing out of the former, and fresh being supplied by the latter. About 4½ miles were done from the Italian end, and the rest from the French. Four years after the boring was commenced, compressed air was first used for running drills on the Italian side. Immense "compressors" were necessary, which were worked by water-power, and the air compressed to one-sixth, or a pressure of six atmospheres. Ten machine drills have been constantly at work at each end, but those on the French side did not begin until 1863. Powder and nitro-glycerine were used, but we have no statistics as to their relative merits.

The "shifts" were eight hours each, similar to those on the Hoosac tunnel, giving the men 16 hours rest alternately. The wages paid miners were about 5 francs per day, and "muckers" about 3 francs per day.

Many lives have necessarily been lost during this great work, but far less than one would suppose; probably from 600 to 800 in all, so far as we have heard from time to time.

We have not seen the whole cost of the work mentioned so far, but it cannot be much short of 160,000,000 francs, or 29,900,000 dollars.—*Scientific American.*

The opening of the Mont Cenis tunnel will no doubt give an impulse to the construction of other tunnels through mountain ranges; and it becomes important to review the different expedients for boring tunnels which are now available, with the view of ascertaining which are the cheapest and most expeditious, as also whether better methods than any now existing might not be suggested. In the Mont Cenis tunnel, the work proceeded at an accelerated pace towards the close, partly no doubt from the increased dexterity of the workmen, but partly also from improvements in the apparatus; and further improvement will of course still further accelerate the pace. In the case of tunnels through earth or soft rock the boring may, no doubt, be accomplished rapidly by boring instruments such as are now largely used in boring wells; and as the borer travels onward the space behind it may be arched round with brick and cement, or with cast-iron tubbing. For hard rock, however, this plan will not answer; and the core of most great mountain chains consists of hard rock, generally igneous. At present, such rock is pierced by boring holes in it by a steel jumper, struck by a hammer, which may be impelled either by hand, in the way adopted by quarrymen, or by any other motive force; or the holes may be bored by diamond-faced drills rotated by a stream of water or otherwise. In the holes gunpowder or other explosive substance is placed, and fired at intervals, when portions of the rock are burst out, which are from time to time removed. This is a very tedious process, and it is very important that it should be superseded by a better. In India very large stones are quarried by the agency of heat, a fire being employed to heat the stone along a certain line, and this line, after having been heated, being suddenly cooled by water, the stone cracks, and may then be removed. The same principle may, no doubt, be adopted in the excavation of rock tunnels, the face being heated with gas brought in pipes from the outside.

In the sitting of the French Academy of Sciences on Sept. 18, 1871, M. Elie de Beaumont, the Perpetual Secretary, read an elaborate paper for eliciting the scientific teachings which may be drawn from a close examination of the collection to be exhibited in the School of Mines at Paris. That collection, which was originally of 127 specimens, has received 69 new specimens, which brings the total number to 196 specimens altogether.

The old collection and the old specimens were presented to the Academy on July 4, 1870, being described under 127 numbers in the *comptes-rendus*, and exhibited in the School of Mines Museum. The new numbers are placed in a continuous series with the others under the same numbers, and distinguished by *bis*, *ter*, &c. Each specimen is supplied with a label showing the distance of the place where it was collected from the opening

of the tunnel. The Parisian collection can be compared with any other, as well as with the original collection, which is kept in Turin.

According to M. Elie de Beaumont's classifications, all these 196 specimens can be ranged under six different headings, having respectively the following vertical thickness, which is found by a special calculation deriving it from horizontal length in the tunnel and inclination:—1, zone anthraciteuse, 1,137 metres, 41; 2, zone des quartzites, 381 metres, 40; 3, zone calcareo gypseuses, 496 metres, 07; 4, zone calcaire schisteux sup., 1,604 metres, 46; 5, zone calc. schisteux moylen, 1,508 metres, 95; 6, zone cal. schisteux inf., 2,023 metres, 49.

The end of the sixth zone was not found.

The differences between the three zones for calcaire schisteux are trifling, and their total thickness is more than 5,000 metres.

The total vertical thickness explored was more than 7,000 metres.

The general colour is grey, or, rather, black, and the colouring matter is mostly carbon. Two other elements are very common—first, talc, and secondly, sand hyaline, very small, very hard.

Very few fossils were met with, having been destroyed by a subsequent crystallisation.

It is necessary to acknowledge that, generally speaking, there is a single stratum of 7,000 feet, which was perforated without exhibiting any very startling difference. It is a part of a single enormous formation, in spite of a few special differences.

The last commotions which have created Mont Cenis and made it emerge from the bottom of the sea have produced many cracks in relatively modern times. But all these faults were filled up with quartz in a perfect manner. The infiltrations amount to nothing practically. The only spring which was discovered is situated near Modane, and gives only seven gallons per minute. The water is cold. Contractors were obliged to send to Modane and Bardonêche for the water required for drinking, and for grinding the stone. It is to be noted that working men were found to be practically better acquainted with the differences of the stone according to the stratum perforated actually than any theoretical mineralogist in existence.

Mont Blanc, although being 4,800 metres above the level of the sea, is only 3,500 above its own basis. So the vertical distance of perforated stratum is strictly equal to two Mont Blancs. It is something like one whole Himalaya. M. Sismonda presented to the Royal Academy of Sciences, Turin, in the sitting of December 5, 1866, a paper entitled "*Nuove osservazioni geologiche sulle rocce anthracitifere delle Alpi,*" at the end of which was printed a map drawn by M. Sismonda 25 years ago, and exhibiting the theoretical succession of strata. Everything was found in the place where it was supposed to be by M. Sismonda. Verification was absolute on an immense scale, so it is possible to say, "That for the learned men the mountains are

made of glass, as their eyes can see everything within their abysses."

No artesian well has ever given an opportunity to be compared with the perforation of Mont Cenis, as the deepest bored by European engineers is only 1,000 metres, and by Chinese with their rope only 3,000 metres. Very likely if a tunnel is ever to be perforated through crystalline mountains of truly granitic and volcanic formation, other results might be found.

THE LONGEST TUNNEL IN ENGLAND.

THE London and North-Western Railway, from Liverpool and Manchester to Huddersfield and the North, passes through a range of hills separating Marsden on the Yorkshire side and Diggle on the Lancashire side, the range bearing the name of Stand Edge, and it has now three tunnels running through it—one a canal tunnel, and the other two for the purposes of the railway. The first-named was commenced in 1794, and completed in 1811; length 5,451 yards, or three miles and 171 yards; cost, 123,803*l.*; and the loss of life during its progress was serious. The first of the two railway tunnels was made by Mr. T. Nicholson, contractor for the Woodhead tunnel, which is shorter than the Stand Edge one by about 40 yards, Stand Edge being three miles and 60 yards long. It was commenced in 1845 and completed in November 1848; the cost was 171,003*l.* 12*s.* 3½*d.*, of the approaches, 30,605*l.*, making a total of 201,608*l.*, and the largest number of men employed on the undertaking was 1,953. Nine fatal accidents occurred in its construction. Messrs. Thomas Nelson and Sons, of Carlisle, were the contractors for the new tunnel; the work was commenced in the middle of April 1868, and was completed in the middle of October 1870, or six months earlier than the time specified. Its exact length is 5,435 yards, one yard less than its twin tunnel; but the actual length constructed by the Messrs. Nelson is 5,297 2-3 yards, the difference arising from a short piece at each end having been made when the first railway tunnel was executed. The whole length is lined with red bricks, faced with blue Staffordshire bricks. The height of the tunnel inside the brickwork is 20 ft., and the width 15 ft. The total quantity of brickwork built is 52,156 cubic yards, the total number of bricks used being 16,831,149, the weight of which amounts to 68,000 tons; 6,271 tons of coal, 472 tons of coke, 2,421 tons of lime, 140 tons of cement were consumed; and of powder 1,744 casks, equal to 174,400 lb.; fuzees, 35,853 coils, each 25 ft., equal to 170 miles; candles, 8,745 dozen pounds, equal to 104,940 lb.; oil, 6,416 gallons; and vast quantities of timber were used. The rubbish was conveyed away by means of tramways, which ran through passages under the railway, and was tipped into boats on the canal before mentioned. It was conveyed through "break-ups," or cross-headings, of which Messrs. Nelson constructed 21; but only 16 were used

at one time. For the conveyance of the material used in the construction of the tunnels 25 boats and four steamboats were constantly plying, and an immense expense had to be incurred in erecting huts, providing business offices, and putting down costly plant for economising labour. Only one life was lost during the construction.—*Times.*

TUNNELLING MACHINES.

COL. VON SCHMIDT, of San Francisco, has invented a machine for tunnel-boring—a machine which is intended to meet the requirements of the latest scheme extant, the Tahoe water-project. According to the *Bulletin*, the machine is constructed upon the severance diamond-drill principle; but in the mode of application the machine differs materially from all others now in use. The Von Schmidt drill will consist of a circular wheel 8 ft. in diameter. Imbedded in the rim of the wheel, each revolving on its own account, will be 24 diamond drills, 1 ft. apart. In the centre of the wheel, according to the model, is a single drill, and this is kept 1 ft. in advance of the other drills. The wheel is calculated to make 800 revolutions per minute, the drills revolving at a higher rate of speed. The periphery of the tunnel will be on the scale of 8 ft.; the groove cut by the drills will be 2 in. wide and 3 ft. deep. It is intended to load the centre hole alone, then run the machine back on the track, and raise the lower half of the wheel on hinges. The blast is fired, and the great cheese of rock crumbles in pieces. The machine is constructed so as to admit of 3 ft. space inside the wheels, between its framework and the bed of the tunnel, thus giving facilities for removing the *débris* afforded by an inner car-track. The machine will be driven by compressed air.

The invention of Mr. T. F. Henley, Pimlico, as described in the *Mining Journal*, consists of a tool-holder, or head, adapted for receiving chisels or tools suitable for cutting rock. This tool-holder is combined with an arm or shaft, the two together being called the ram-head and ram-shaft, or, collectively, the ram. This ram is mounted by suitable connexions on a main frame or base plate, which is fitted with wheels or skids and guide-rollers for the purpose of advancing or withdrawing the machine, as may be required. The ram is made to receive a fore and aft movement of percussion from any suitable motor, simultaneously with a horizontal motion to the right or left, and *vice versâ*, by means of mechanical arrangements.

A Machine Tunnelling Company has been set a-going, with a capital of 30,000*l.*, in shares of 5*l.* each, for the purpose of acquiring and working the tunnel-driving machinery recently patented by Captain Beaumont, M.P., and Mr. C. J. Appleby, C.E. The machine has been practically tested. Mr. T. J. Bewick, C.E., of Haydon Bridge, certifies that under unfavourable circumstances they progressed at the rate of about 15 yards in a month,

and that it is subject to but little wear and tear. Compared with ordinary manual labour, it is estimated that the work done was about double. The machine has the advantage that it can work several drills simultaneously, and each drill can bore an inch a minute in the hardest granite. A reliable mode of setting the diamonds in the drill-head is still to be discovered. The diamonds cost 10*s.* or 12*s.* each, and quickly work out of the setting.—*Builder.*

THE BROADWAY UNDERGROUND RAILWAY.

This structure commences at the corner of Warren Street (New York) and extends in a curve directly down Broadway. The lower terminus is intended to be at the South Ferry; but the present operating section only extends a little below the City Hall, a distance of some 300 feet. The bed of the railway is 21 ft. below the surface of Broadway, and the diameter of the tunnel 9 ft. The passenger car is about the same size as the ordinary street cars. It is very tastefully fitted up and brilliantly lighted, and has seats for 22 persons. It is propelled by means of a strong blast of air, which is supplied to the tunnel by a gigantic blowing machine.

The whole operation is described as being exceedingly simple and effective. The visitor enters the waiting-room, an elegant apartment, but wholly underground, at the end of which is seen the mouth of the tunnel and the car. On reaching the lower end of the tunnel, the car moves instantly back to Warren Street again, and so on. The air is so elastic that the changes of motion in the car are effected with exceeding gentleness, and are almost imperceptible to the visitor.

The car is run by telegraph; that is to say, the wheels of the car, at certain points on the route, press a telegraph key, sending a signal to the engineer, who turns a valve, and thus reverses the air current, without stoppage of the machinery.

The Aëoler or blowing machine by which the air current is produced, consists of a pair of great wings, geared together, and turned by steam. It is capable of discharging 100,000 cubic feet of air per minute. The south end of the tunnel is provided with a lateral air-shaft, which opens in the grass-plot of the City Hall Park. The air current thus traverses through and through the tunnel, the atmosphere of which is thus kept pure and fresh.

During the construction of the tunnel the entire travel of Broadway, omnibuses, carts, hacks, and other vehicles in endless procession, passed on as usual directly over the heads of the workmen. They were safely protected within the sides of an immense boring machine, by which the bowels of the street were excavated. It is pushed forward into the earth by means of powerful hydraulic rams, and as fast as it advances the masonry is built up within its rear. The general plan of the Company is to lay a double line of tubes from the South Ferry, under Broad-

way, the entire length of the island, with a branch at Union Square, under Fourth Avenue, to Harlem River. Such a road would have capacity for carrying 40,000 passengers per hour.—*Mechanics Magazine.*

RAILWAY REFORM.

Mr. R. H. Fairlie has read to the British Association a paper "On Railway Reform." He argued in favour of adopting a narrow gauge, and especially a gauge of 3 ft. He said: "Experience has shown that 3 ft. 6 in. can be made a highly economical and efficient width, but it does not by any means follow that it is the most serviceable and most efficient, any more than it follows that the accidental 4 ft. 8 ½in. was all that could be desired, even though an Act of Parliament has made it an article of belief. On the contrary, as our knowledge and experience increase, we are enabled to approach more and more nearly to that happy mean on either side of which is error. While, on the one hand, there is every necessity for obtaining such a gauge as will afford a good and useful width of vehicles, on the other, it is necessary to avoid such narrow limits as would necessitate the introduction of too great overhang on each side of the rails. The 3 ft. gauge appears to comply with all the necessary conditions better than any other, and it is from no mere theorising that the author lends all his influence towards its adoption. There is a certain amount of saving in first cost as compared with the 3 ft. 6 in.—not a large amount, but worth considering. This, however, may be left out of the discussion for the present. The all-important matters are to place upon the rails a thoroughly efficient stock that shall possess a *maximum* of capacity and a *minimum* of weight, and to supply engine power under the most economical circumstances, and it is easier to accomplish these objects on the 3 ft. gauge than upon any other. This conclusion follows both from a comparison of the actual work done on the railways of the 3 ft. 6 in. gauge with that which can be accomplished with the 3 ft. gauge, and because, having in view the practical requirements of goods traffic, it is possible so to obtain an ample floor-area with less dead weight than can be secured by any other width; on a wider gauge the dead weight increases, on a narrower one the capacity diminishes. The author quoted figures to show that to carry 30 tons of goods on the Norwegian or Queensland 3 ft. 6 in. gauge, the proportion of one ton per waggon being preserved, 92 per cent. of the weight of rolling stock used on the 4 ft. 8½ in. would be required, as against only 43 per cent. on a 3 ft. gauge, showing a saving of 47 per cent. on the latter as compared with the 3 ft. 6 in. Of course, if the waggons were loaded up to full capacity, those percentages would be very much changed. It was to this point especially that he wished to direct attention, as upon it the economy of the 3 ft. gauge rests.

THE RAILWAYS OF THE UNITED KINGDOM.

What will possibly surprise at least some is the Fact appearing very strikingly in the Board of Trade Report, that there are not less than 599 railway companies in the United Kingdom. England alone has 434 Companies, while Scotland has 80, and Ireland 85 Companies. The lines of about one-half the total of these Companies are either leased to or worked by the great leaders of our railway republic—true *res publica* if ever there was one; but the other half are independent, small enough as often is the area of their sovereignty. As far as can be made out from the blue folio, in which the 599 are marshalled in strictly impartial alphabetical order, the smallest of all independent undertakings in the three kingdoms, as far as regards income, is the railway from Edenham to Little Bytham, four miles long (the sole property, we believe, of Lord Willoughby de Eresby), the total earnings of which in the year 1870 amounted to no more than 428*l.*; while the smallest line, as regards mileage, is the Ryde Pier, the total length of which is about half-a-mile, but the revenue of which in 1870 was 10,168*l.*, the little concern carrying 111,983 passengers, the trains running 8,911 miles. Contrast these two smallest with the largest of our Companies. The "king of railways," the London and North-Western, represented by a length of 1,507 miles open for traffic, carried in the course of the 12 months ending December 31, 1870, the enormous number of 33,340,610 passengers, being just about the total population of all England, Scotland, and Ireland. The number of miles run by the trains of the London and North-Western Railway in the year 1870 was 25,037,577, in other words, a distance of more than 100 times that of the moon from the earth, or, say, equal to 50 return journeys to and from the moon. The gross receipts of the London and North-Western in the year from passenger traffic amounted to 2,942,286*l.*, and from goods traffic to 3,975,723*l.*, the total revenue being 7,014,713*l.*, or almost exactly the same as the national income of Belgium. Next in length of mileage to the London and North-Western comes the Great Western, with 1,387 miles open, which earned in 1870 the handsome revenue of 4,316,498*l.*, being equal to that of Bavaria; while behind the Great Western in mileage, but above it in income, stands the North-Eastern, with 1,281 miles open for traffic, the receipts of which last year amounted to 4,595,263*l.*, a sum equal to the aggregate revenues of Sweden and Denmark.—*Railway News.*

WIRE TRAMWAYS.

We have watched with much interest the development of the Wire Tramway system of transport, and have from time to time noticed its progress. Its spread over several foreign countries, and some of our colonies, has been most remarkable, no less than 45 lines having already been undertaken, most of which are con-

structed and in successful operation. One of the most remarkable instances of its success is that of the line constructed for the Ebertrard and Aurora Company, in Nevada, U.S. The materials for this line were forwarded from England late in the autumn of last year, and reached Nevada whilst the whole of the mountain district, in which they were to be placed, was enveloped in snow. Nevertheless, during the spring the line (of nearly three miles in length) was constructed, and has recently been put into most successful operation, a telegram having been received by the directors of the Ebertrardt Company, in London, to the effect that the line was working splendidly. On it there are grades of 1 in 3, and spans from post to post of some hundreds of feet. The quantity of material carried is about 200 tons a-day, and it may safely be asserted that the difficulties of this mountain country could not have been overcome for the purposes of so considerable a transport by the employment of any other means. Lines have been forwarded to Peru and Brazil for sugar-cane transport. One has been opened in Peru, but too late for the season, and another in St. Kitts, from which most favourable results have been obtained. In Austria the system has been applied to the carriage of turf, and in Bohemia to the carriage of fire-clay from pits requiring an ascent of an angle of 30 degrees from the horizontal.

The Indian Government are now adapting the system to the development of the Salt Mines in the Punjaub; and the Spanish Government have applied it to a fifteen-mile length, in the mountain of Asturias, of which about nine miles are already in operation. The War Office have taken a line for transporting powder casks from the store at Purfleet to the examining shed and back again, the inducement being that the transport could by this means be effected without bringing either animal or steam power within the precincts of the establishment. The power is to be supplied from a boiler situated at a distance of several hundred yards from the powder stores. Stimulated by the rapidly increasing demands not only of our colonies, but the development of mineral and agricultural productions, means of transport are now in great demand, and rapidly on the increase.

The traction engine has received some remarkable improvements of late, and promises to aid, if not to frequently supersede horses on common roads, but the wire-tramway system has the advantage of not requiring a ready-made road for its employment, and is undoubtedly the pioneer of all existing means of transport. —*Mechanics' Magazine.*

TRAMWAY-CARRIAGE STEERING APPARATUS.

Difficulties and inconvenience have arisen in the working of the tramway system in the metropolis at places where it is necessary to give to the carriages a slight deviation from the

line upon which they have been moving, and cause them to pass into a branch or siding. This has already led to the application of considerable mechanical ingenuity to the subject, and some patented apparatus, the invention of Mr. Samuel Norman, of Westminster Road, is said to supply the necessary remedy in a simple manner. The specifications and drawings set forth as many as twenty-nine modes, which may be used according to the construction of the carriage. The principal, and perhaps the simplest, method is that of partially skidding one of the leading wheels of the carriage on the side which corresponds to the inner side of the curve.

A NEW DOUBLE BOGIE LOCOMOTIVE.

A NEW Double Bogie Locomotive has been constructed after the design of Mr. Fairlie. The engine "Hercules" is for the Iquique Railway in Peru. It has four 15 in. cylinders, of 22 in. stroke, and its total weight (60 tons) rests upon 12 wheels, arranged in two groups of six, coupled together, and all assisting in the adhesion. It will be required to work heavy traffic over a gradient of 1 in 25 for 11 miles, and round curves of three chains; and during the experiments it went round curves of 2¼ chains with the greatest facility, the deflection of the centre of the leading bogie platform from the end of the boiler amounting to 14 inches. It was next taken through a boiler shop and a smith's shop, and so upon a very irregular and badly kept piece of line belonging to the Midland Company. Here its trip was interrupted by certain bridges and platforms which it could not pass; but it ran up and down, over a length of about a quarter of a mile, with perfect smoothness. Its passage over roughly laid points was distinctly heard by those riding upon it, but communicated no jolt to the driver's platform. It has been built by the Avonside Company, for Messrs. Montero, of Peru.

STUPENDOUS RAILWAY BRIDGE.

THE Sutlej Bridge, lately opened on the Delhi Railway, is one of the longest in the world, a circumstance rendered necessary not so much by the size of the river as by its propensity to wander about at this spot. This risk would have been obviated if the crossing-place had been fixed a few miles higher up, where the ground is firm. The traffic on the Scinde, Punjaub, and Delhi Railway has somewhat increased during the past year; but the increase is chiefly due to the increased length opened. Last year the weekly receipts were 9*l*. 6*s*. per mile, and the working expenses 70 per cent. of the receipts, leaving a loss to be made up by the Indian Government under their guarantee estimated at 362,114*l*. a-year.—*Illustrated London News.*

THE PNEUMATIC DESPATCH TUBES.

A PAPER descriptive of the "Pneumatic Despatch Tubes—the Circuit System," by Mr. Carl Siemens, has been read to the Institution of Civil Engineers. After referring to the pneumatic tubes laid by the Electric and International Telegraph Company to connect their central station in Telegraph Street with their nearest branch stations in the City, a system of tubes designed and carried out by Mr. Latimer Clark and Mr. Varley, which had been considerably extended since the telegraphs had passed into the hands of the postal authorities, Mr. Siemens stated that in April 1863 the Prussian Government applied to Messrs. Siemens and Halske, of Berlin, to suggest a system of pneumatic tubes for that city. That firm proposed laying tubes, arranged in circuit, to be traversed by a continuous air current always kept flowing in the same direction. The peculiarities of this system—namely, the continuous current of air and the power of putting carriers into the tubes at any point—gave it great superiority over previous systems in the amount of work it was capable of doing. The Central Telegraph Station and the Exchange at Berlin were connected together on this system in 1865, by means of two parallel lines of drawn wrought-iron tubing, of 2½ in. internal diameter, one tube being used exclusively for the passage of carriers in one direction, and the other for carriers going in the opposite direction. The continuous current of air for these tubes was produced by means of a steam engine working a double-acting air-pump in the basement of the telegraph station. Allusion was then made to the circular pneumatic system in Paris, in which a continuous current of air was not used; and to the pneumatic line in London from Euston Station *viâ* Holborn to the General Post Office, for the conveyance of large parcels.

A minute account was then given of the experimental circuit laid by Messrs. Siemens between the Central Telegraph Station and the General Post Office in St. Martin's-le-Grand, which was opened for traffic in February 1870, and had subsequently been extended to Fleet Street and to the West Strand office. The different stations were connected by two lines of wrought-iron tubing, having an internal diameter of 3 inches. Both lines were laid in the same trench, at a depth of about 12 inches below the pavement, and parallel to one another. The tubes forming the circuit were of an average length of 18 ft. 8 in., a common lead-and-yarn joint making the connexion between each tube. A current of air was kept constantly circulating through the tubes by means of a steam-engine and double-acting air-pump placed in the basement of the Central Telegraph Station. Each station on the circuit had two sending and receiving instruments, one on the up and one on the down line of tubes. The carriers for the reception of telegrams, letters, &c., consisted of small cylinders made of gutta-percha, papier-mâché or tin, covered with felt, drugget, or leather. It was found in

practice that the carriers need not fit the tubes at all accurately. Mr. Culley, M. Inst. C.E., chief engineer of the Post Office Telegraphs, had adopted the block system, such as was used on railways, for working the tubes. The total length of line now working in London, from Telegraph Street to the West Strand office and back, was 6,890 yds. It was found by experiment that the speed of the carrier was much greater as it approached the vacuum end of the tube than it was at the other end. The necessity of having a steam engine with air pumps and reservoirs was a great hindrance to the general introduction of pueumatic tubes, but this inconvenience had been successfully removed by the construction of an exhausting apparatus working by the direct action of steam upon a current of air. In this exhausting apparatus the steam from a boiler was made to issue, in the form of a hollow cylinder, from an angular nozzle placed in the centre of the apparatus, the opening having a width of about one millimetre all round. The steam issuing in this form had the greatest possible surface, both inside and out, for contact with the air in the apparatus, which air was in connexion with, and was drawn from, the pneumatic tubes. With one of these exhausters a vacuum equal to a column of 23 inches of mercury was obtained with a less expenditure of steam than would be required to work a steam engine and pump to effect the same object. The principal recommendation of the steam exhauster, besides its extreme simplicity and the small space it occupied, was its cheapness of construction, as the cost only amounted to about one-twentieth part of an engine and pumps. Up to the present time, so far as the public was concerned, the pneumatic tubes in London, Berlin, and Paris had only been used for the conveyance of telegraphic messages, but the Post Office authorities had already considered the question whether it would not be advantageous to have the letter-post service in London executed by means of pneumatic tubes. With such a system of distribution an accumulation of letters at principal offices would be entirely avoided.—*Times.*

THE TIBER.

One of the first results of the new life arising in Rome as a consequence of the downfall of the temporal power will be the realization of a scheme which has long been in contemplation, but which under the Papal Government might, perhaps, never have gone beyond the limits of a wild and vague chimerical project—we mean the exploration of the bed of the Tiber. The Italians, who now for the first time since Constantine feel as if the great city were indeed their own, have an almost boundless, yet not exaggerated, idea of the artistic, archæological, and other treasures buried under the yellow sands which the river has accumulated on the spot for these last 3,000 years. Every revolution, they say, had to pay its tribute to the river. It was the Tiber which received the statues of an unpopular Emperor,

his armour, and even his diadem and other insignia, even when the body itself was not flung into its waters. In more calamitous times, when Alaric, Genseric, Totila, or, in later ages, the Norman, the Swabian, the Austrian thundered at the gates, the inhabitants, hopeless for their lives, had no other means of baffling the invader's cupidity than by committing to the Tiber the spoils which must otherwise inevitably fall into the plunderer's hands. "The Tiber will have its own share" is a common saying among the Romans at the present day, and the universal receptacle of all that is lost has been further enriched by fires, inundations, wrecking of galleys laden with the wealth of the ancient and mediæval world, and the materials of ruined temples and palaces, of which the river afforded the most expeditious way of clearing the ground. We may imagine what wonders would gladden our eyes if we could bid the ocean restore whatever it hides in its depths. But the Tiber flows over, if not as vast and rich, at least as interesting a variety of Old World relics, all lying undisturbed under fathoms of alluvial soil which has buried them for ages, and only awaiting the enterprising generation which will lay these long-forgotten treasures into the light of day.

The scheme of a thorough excavation of the bed of the Tiber, with a view to call the river to account and put it "in liquidation," compelling it to disgorge its illgotten gains, has now been taken up by an Italian association, at the head of which is the well-known Signor Alessandro Castellani; but which relies on the co-operation of many artists, antiquaries, and other learned men of Europe and America, all of whom have been strongly urging the speedy commencement of an undertaking which has already been too long delayed. It is not as a commercial or a financial speculation that the work is to be executed. Those who set about it expect no other return for their trouble and expense than the immense gain sure to accrue from it to art and history—to archæological knowledge in all its branches. The Society reckons, of course, on the aid of the other company, which has lately been formed with a view to protect the city from those periodical inundations of the Tiber against which the Papal Government would, or could, find no remedy; and many of the contrivances by which our own engineers have laid the foundations of the Thames Embankment will find their application in extensive operations which are now to be carried on along the banks and in the bed of the Roman river. Encouragement to the Italian Society in this truly great national undertaking comes in from every quarter, and a Parisian banking-house of almost boundless wealth and munificence has volunteered funds to defray the first expenses, so as to give the start to an enterprise which will certainly experience no lack of support in the sequel.—*Times.*

ANCIENT WAR-GALLEYS.

An essay, by Mr. W. S. Lindsay, the well-known ship-owner, formerly M.P. for Tynemouth and Sunderland, on the method of equipping and rowing the Ancient War-Galleys, has been read to the Royal Society, and has now been printed. It seems to be one chapter of a comprehensive history of the shipping of all nations, which Mr. Lindsay is engaged in composing. There is no more difficult problem of antiquarian research, connected with a question of mechanical science, than to conceive how the banks, or tiers, of oars were arranged in the triremes, the quadriremes, and even septiremes and octoremes, so as not to impede the action of each other. Such vessels as were certainly employed in naval warfare by the Carthaginians, or in the fleet of Mark Antony at the battle of Actium, even though we reject the account of Ptolemy Philopater's enormous ship with forty banks of rowers, whose oars were 38 cubits, or 57 ft., in length, are puzzling to think of. Mr. Lindsay has investigated this curious subject with much practical sagacity, as might have been expected from his great knowledge and experience of nautical affairs. His treatise is the more easily understood by the aid of the lithographs and wood-engravings printed with the text. It is well worthy of the student's attention.—*Illustrated London News.*

THE ARCHIMEDEAN SCREW CENTRIFUGAL PUMPS.

There has been read to the Institution of Civil Engineers, a paper "On the Archimedean Screw for Lifting Water," by Mr. Wilfrid Airy. This communication was intended to supply information regarding the best form of the Archimedean screw, and its effect when laid at different angles of inclination to the horizon. After suggesting that the previous neglect of this subject was probably owing to the mathematical and practical difficulties attending the construction of screws in the ordinary way—viz. with the threads at right angles to the surface of the core—the author stated that he had adopted another principle of forming the spiral threads, which would simplify the work of construction and produce a more efficient machine. This was to make the spiral threads on the natural and developable system. If an annular piece of card or tin be wrapped upon a cylindrical core, having its edge retained in a shallow spiral groove on the surface of the core, it would naturally take up a fixed and determinate position, not at right angles to the surface of the core, but inclined to it, and inclined to it at an angle depending only upon the inclination of the spiral groove on the core. The core could only be constructed approximately, by using a great number of small pieces. The developable threads also produced a more efficient machine than the threads of the usual form, as was shown by reference to tabular diagrams.

Experiments formed the basis of the investigation, and it was deduced from them:—

1. That the quicker the spiral the flatter must the machine be laid to produce its best effect.

2. That screws of quick spiral angle, when laid at their best angle of inclination, delivered a far greater volume of water per revolution than those of slower spiral angle, when laid at their best angle of inclination.

In the most favourable case, the useful effect of the screw appeared at 88 per cent.; and it was concluded that, after making allowance for certain small losses referred to, the useful effect of a well-constructed screw should not be less than 85 per cent.

Reference was then made, by way of comparison, to other machines commonly used for low lifts—viz. suction-pumps, centrifugal pumps, open Archimedean screws, scoop-wheels, chair-pumps, and Persian wheels; and the paper concluded by pointing out the various advantages of the Archimedean screw, more particularly as regards its durability, simplicity, and useful effect.

The second paper read was on "Centrifugal Pumps," by Mr. David Thomson. The practical rules of construction were:—

1. The arms of the fan were curved backwards, according to principles of construction, which were explained by diagrams. The depth of the fan was one-fourth of the diameter, and the central opening for the admission of the water was about nine-sixteenths of the diameter. The space allowed in the case round the fan should be of ample dimensions.

2. The best duty was given when the speed of the periphery of the fan exceeded the velocity of a falling body, due to the height of the lift, by from 6 ft. to 8 ft. per second.

3. A fan 12 in. in diameter, and proportioned as described, would discharge 1,200 gallons of water per minute.

4. If the diameter of the fan was varied (the speed of the periphery and the lift remaining the same), the delivery of water was increased or diminished directly as the square of the diameter.

5. When a centrifugal pump, properly proportioned, was worked by a steam engine, the duty that might be realised ranged from 55 per cent. in the smaller-sized pumps to 70 per cent. in the larger machines, of the power shown by the indicator diagrams.

SEWING MACHINES.

These Machines, which at first were almost entirely imported from America, are now most extensively manufactured in Glasgow. In one week two large consignments left the Clyde. One valued at 1,000*l.* (cost price). was shipped per the *Neptune*, steamer, for Havre; and the other, valued at 2,700*l.*, per *Lochearn*, for Melbourne.—*Scotsman.*

ACTION OF SEA WAVES ON SHIPS.

W. J. Macquorn Rankine, C.E., has given a discourse at the Royal Institution, on this important subject, in which, after noticing the experimental and theoretical researches of the Webers, Airy, Scott Russell, and Caligney, he proceeded fully to explain the principles discovered by Mr. Froude. A ship or other buoyant vessel, immersed in water, has the tendency to perform the same motions, which in her absence the water she or it displaces would itself have made. In still water the forces of buoyancy and gravity keep the ship in one stable position, which the skill of the naval architect can previously determine, and if heeled over, or this stable position be otherwise disturbed, these same forces restore her to the static position, the amount of force with which this is effected constituting the *statical stability* or *stiffness* of the ship. These same forces acting on a ship amongst waves are constantly forcing her towards the position called *upright to the wave surface*; that is, with the original axis vertical to the wave surface. Broad and shallow rafts do accompany the wave surface in its rolling, and the more a ship yields to this tendency, the less of necessity is the amount of her *stiffness*, but, on the other hand, a vessel possessing great *stiffness* may be very deficient in *steadiness*. The natural period of rolling of a ship depends on her stiffness and her amount of inertia, the former tending to shorten. and the latter to lengthen, the amount and time of her rolling. When the periods of rolling and succession of waves coincide, the greatest amount of unsteadiness on the part of the vessel exists; and if these periods were exactly coincident, the succession of impulses would eventually cause her to upset.

In well-designed ships a safeguard exists against the occurrence of such disasters. It is well known that no pendulum is absolutely isochronous, but great oscillations occupy a longer time than smaller ones. The oscillations of a ship partake of the pendulous character, and in like manner her natural rolling, even if made to roll artificially in still water, is never absolutely isochronous; but the greater angles of roll occupy longer periods than the smaller. Hence, supposing a ship to encounter waves of a period equal to her own natural period for small angles of roll, though her angle of rolling is progressively increased her natural periodic time of rolling is at the same time likewise increased, and at last gets beyond the point at which it is identical with the impact of the waves; so that these, instead of increasing, then tend to diminish the ship's roll, until it falls again into their periodic time. Thus an alternation of larger and smaller angles of roll is occasioned, which, however, can never (from this cause alone) exceed a certain amount.

From this principle it follows that it is essential that in designing a vessel care should be taken to secure the natural period for the smallest rolling angles, being nothing *less* than the period

of the waves; otherwise the effect of the progressive angular increase will be to produce, instead of destroying, periodic coincidence; and great unsteadiness of motion, possibly great danger also, must needs arise.

These principles the lecturer described as being the latest additions to our knowledge of the theory of the relations between ships and sea-waves. The motions under the different circumstances above described were cleverly illustrated by experiments on a machine so constructed as to imitate the dynamical conditions of a ship rolling amongst waves.

AN IMPROVED MARINE STEAM-ENGINE.

THE attention of the makers and employers of Marine Steam Engines has been turned towards the best methods of insuring economy of fuel, and a contrivance by which this result has for some time been obtained on land has now for the first time been employed with good results at sea.

Messrs. J. and F. Howard, of Bedford, are the patentees of a steam boiler which they call their "patent safety;" and which consists, in effect, of many iron tubes, each forming a small boiler, and between and around which the flame and heated gases from the furnace are allowed to play. The tubes are so connected by other tubes at their extremities that their aggregate yield of steam can be used just as if it came from a single source, and the great advantage of the arrangement is that the steam pressure can be enormously increased without danger. The tubes are each tested to a pressure of 500 lb. to the square inch; and are commonly worked under a pressure of 140 lb. Any explosion would be limited to a single tube, and, as the fragments of this tube would be confined by the outer case of the boiler, the only immediate effect would be the extinction of the fire by the water that would escape. No explosion has yet occurred in any boiler in actual use; but the Messrs. Howard have repeatedly tested the matter by experiment.

It is thoroughly understood that the use of steam at high pressure is an important step towards diminishing the consumption of coal, and the results obtained from Messrs. Howard's boilers at Messrs. Crossley's and other works on land have led to an endeavour to use the same engines on board ship. So far as can be judged from a single trial, this endeavour may be said to have been completely successful. In the newly-built steamer *Fairy Dell*, the first vessel fitted with Howard's safety boilers, the quantity of coal burnt was not accurately tested, but it is believed that the ordinary consumption will not exceed two pounds of common steam coal per indicated horse-power per hour. It was found that a run of about 18 miles occupied 80 minutes, and that the coal consumed was 320 lb. The average steam pressure was from 140 lb. to 150 lb. on the square inch. From these data it may be inferred that the *Fairy Dell* would burn

only about half as much coal as a vessel with engines and boilers of the usual kind.

Let it be supposed that an ordinary steamship would require 1,500 tons of coal for her voyage to China and back. She would take, say, 1,000 tons at 10*s.* per ton, in the north, and would buy 500 tons in the Chinese ports at 40*s.* per ton, thus spending 1,500*l.* in coal. A vessel with engines and boilers like those of the *Fairy Dell* would need only 750 tons for the double voyage. She would obtain the whole of this in the north at 10*s.* (375*l.*), thus effecting a saving of 1,125*l.* in money, and increasing the available tonnage for freight by 258 tons on the voyage out, and by 375 tons on the voyage home. The boilers are by Messrs. J. and F. Howard, of Bedford, and the engines by Bates & Co., of Sowerby Bridge. The boilers are on the plan already mentioned, built up of seven-inch tubes; and the engines are on the compound inverted cylinder principle, fitted with surface condensers. The diameter of the high-pressure cylinder is 8½ in., and that of the low-pressure cylinder is 22 inches. With a pressure of from 140 lb. to 150 lb. in the smaller cylinder, these dimensions allow the principle of expansion to be carried out in a very high degree. It speaks well for the arrangement of both engines and boilers that the ordinary engineers and firemen of the Tyne district have found no difficulty in working them.—*Abridged from the Times.*

THE WATER COMPANIES OF LONDON.

THE eight Water Companies of London supply 479,843 inhabited and uninhabited houses, and their daily average supply of water is 104,006,034 gallons, or 25 gallons to each person. The highest temperature of the water as it flowed into the cisterns was 71·1 deg. This temperature was reached on Aug. 12 by the water coming from the East London Company, and it was, of course, vapid and mawkish. While the six other companies were delivering river water in July and August at a temperature of 68 deg, the Kent Company delivered their deep well water at a temperature of 61 deg. in July, and of 59·5 deg in August. But this fact may be related in favour of all the Companies, that the water delivered by them was charged with a smaller average proportion of solid impurity than in 1869. The improvement is to be attributed, however, to a natural and not to an artificial process, for, by reason of the drought which prevailed last year, the Thames and the Lea were chiefly supplied by deep springs. Twelve months ago living organisms were found in the water of the Chelsea, Southwark, Grand Junction, and East London Companies. The use of Clark's process is strongly recommended to soften as well as to purify water. The chalk, oolitic, and green-sand formations around London contain an abundance of water sufficient not only for its present population, but for double its numbers, and after having been sub-

mitted to Clark's process the water is, according to Professor Frankland, of "unsurpassed purity." It is to be hoped that the day is not distant when London will draw all its supply of water, so cool, colourless, refreshing, and safe, from these sources, and that the continued adherence to the old and most objectionable system of an intermittent supply will be abolished. Among all the towns of England London stands alone in the maintenance of the system. The time has arrived when Parliament should provide for a constant service.—*Mechanics' Magazine.*

THAMES WATER.

The House of Commons' Committee on the Metropolis Water Bill have examined Professor Frankland on the removal of impurities from the Thames Water by filtration. He says that animalculæ can be removed, but that it is a question whether the ova do not go through the filtration. He mentions that he met with a few fleas lately in water delivered in London. In answer to one of the counsel who suggested that fleas do no harm, Dr. Frankland admitted that he should think not, but he observed that if there are fleas there may be other hurtful matters passing along with them. He allows that there is no direct evidence that there are any matters hurtful to health in Thames water if efficiently filtered; but unfiltered Thames water in the tidal reaches is known to have produced very severe attacks of illness. The learned counsel remarks that the Thames will be materially improved as the Conservancy Acts get to be enforced higher up the river. and Dr. Frankland agreed that it will be improved, but he does not think that the purified sewage even then admitted into the Thames will be at all fit to drink. He retains the conviction that sewage is never got rid of from that river; 168 miles' run would not get rid of above a third of it. The process of oxidation or destruction is a slow one, and the rivers of this country are not long enough to make it complete. He does not believe that it is got rid of from the Thames because he finds evidence that it is in it. He believes that organic impurities in solution in Thames water might be reduced to half their present amount, either by selection of the water when the river is in good condition and storing it up for use during the time of river floods, if the companies have storage room enough; or by Clark's process of applying milk of lime to the water as it enters the storage reservoirs. In this process a quantity of finely-divided chalk is precipitated in the water, and this attaches to itself the organic matter—dyes itself with it. The effect is to reduce the hardness of the water to about one-fourth of what it was. The total solid impurity is reduced by this process to less than one-half, and the organic element to less than seven-ninths. The cost would be about 13*s.* or 14*s.* per million gallons, and the saving in soap would much more than pay the expense.

Dr. Frankland adds:—With the exception of the Southwark Company's water, which was "slightly turbid and contained moving organisms," the samples of the metropolitan waters have been effectively filtered. Early in the present month the waters supplied by the different companies recovered from the excessive organic impurity which they exhibited during May. As in May so in June, the worst sample of Thames water was delivered by the Southwark Company, and the best by the West Middlesex Company. The West Middlesex water, however, contained considerably more than double the proportion of organic elements present in the New River water, partly drawn from wells and springs in the chalk; and nearly five times the proportion found in the Kent Company's water, exclusively from chalk wells.—*Times.*

PROFESSOR TYNDALL ON THE WATER SUPPLY OF LONDON.

At the Royal Institution Professor Tyndall has delivered a lecture upon "The Scattering of Light," which was, in point of fact, a discourse upon domestic water supply. Having established that the visibility of the track of a beam through water depended upon particles by which the light was reflected, the Professor next placed before the electric lamp a succession of nine bottles, containing samples of the water supplied to their customers by the various London water companies. The turbidity revealed was in every case sufficient to make the audience regard water as a very undesirable beverage. That of the Lambeth Company displayed pre-eminence of a bad kind, that of the Kent Company was by far the clearest; the West Middlesex Company stood second in order of merit; and among the rest there was little to choose. With a reticence more eloquent than words, the lecturer avoided expressing opinions about the dirt that he exhibited; and he also expressly mentioned that pellucidity was no proof of the absence of soluble impurities. He also showed that to cleanse water from suspended dirt was a very difficult matter, and exhibited four specimens of distilled water, a specimen once filtered by Mr. Lipscombe, a specimen that had gone through a silicated carbon filter, and a specimen four times filtered through bibulous paper in the Royal Institution laboratory. These were clear when compared with the waters of the companies; but the track of the beam was plainly visible in all. A specimen of water from the Lake of Geneva was then exhibited in illustration of great natural purity, and here a faint blue line only could be seen. This brought Professor Tyndall to the practical conclusion at which he had been aiming, namely, to an account of the water supply yielded by the English chalk formations. He characterised this as being of the greatest attainable purity, inexhaustible in quantity, and easily accessible for the supply of the metropolis. He described its natural hardness as being such as to render it unfit for domestic use, but explained that by Clark's (lime) process this hardness could be entirely

removed at the central works, and that the water might be delivered in London at a uniform temperature, free from organic impurity or suspended particles, and so soft as to be perfectly adapted for all household purposes. He described Clark's process, and illustrated it before the audience, and finally showed actual results by producing a bottle of water from Canterbury, derived from the chalk, and softened in the manner described. By the side of this was a similar bottle containing the water supplied to the institution, and the two were illuminated together by way of contrast. The difference was like that between peasoup and crystal. Professor Tyndall then read a portion of the report made some years ago by the late Professors Graham and Miller, and by Professor Hofmann, upon the admirable qualities of this chalk water when artificially softened, upon its fitness for the supply of the metropolis, and upon the impolicy of allowing it to pass into private hands; and he concluded by saying that every word that he had read he desired fully and cordially to endorse.

THE NEW RIVER.

At a meeting of the Hertford Council, Councillor Garratt, in moving that a committee be appointed to report upon the rateable value of property belonging to the proprietors of the New River Company within the borough of Hertford, said the New River Company sends to London a daily supply of 26,500,000 gallons of water, from which it receives, by the sale annually, the sum of 252,000*l*., or equal to more than 9,300*l*. per annum for every 1,000,000 gallons supplied daily. Chadwell Spring contributes to that quantity 4,500,000 gallons daily, which is equal to one-sixth, and a trifle over, of the whole supply. The total expenses of the New River, including working expenses, rates, taxes, income-tax, &c., amount to 119,000*l*., leaving a net profit of 133,000*l*. Taking one-sixth of that sum as the profit of the New River from the Chadwell Spring, it amounts to 22,166*l*. 13*s*. 4*d*., which profit is derived from this borough. About 18,500,000 gallons were daily taken from the River Lee, which flows through the borough, and which produces a profit of about 100,000*l*. per annum, after working expenses, rates, taxes, income-tax, &c., are paid. The motion was agreed to.—*Builder.*

WARMING BY HOT WATER.

Messrs. Comyn Ching & Co., of Castle Street, Long Acre, have patented an apparatus for circulating Hot Water, by which the risk of explosion would seem to be avoided. It consists of a small tubular boiler, 11 in. square and 2½ in. deep, fixed at the back of an ordinary stove and communicating with a large conjunctive boiler placed at any convenient adjacent position. A pipe from the house-cistern conveys cold water into the con-

junctive boiler, whence it rapidly circulates through the tubular boiler, returning at once heated to the conjunctive boiler at a higher level than that of the incoming cold water, the pressure of which forces the hot water all over the building by means of an ascending pipe that can be tapped at any part of its length. The unused hot water returns by a third pipe to the conjunctive boiler, whence it again passes through the tubular boiler, and recovers the heat it has lost in its passage through the house. The constant circulation is thus kept up by the pressure of the cold water contained in the house-cistern. Should this become empty, the cessation of pressure prevents any water from leaving the conjunctive boiler, which always remains full. The system certainly has its advantages, and is applicable to all sorts of buildings. The firm tell us with reference to "A Suggestion for Warming Apartments," in the *Builder* recently, that they pass fresh exterior air over or through a boiler, and convey it thence to any room or rooms to be warmed, having a valve in the floor of each, to admit or exclude at will. A correspondent says he has had his own bedroom (size about 20 ft. by 20 ft.), in a bleak situation in the country, warmed on this system with perfect success, and without cost after first expense, which is trifling.—*Builder*.

DOMESTIC WATER SUPPLY.

The importance of an inadequate Supply of Water for domestic purposes cannot be overrated, on this more than on anything else the sanitary condition of towns and cities turns. Morals, also, are affected by water supply to a great extent; for altogether independently of the truth of the axiom of cleanliness being next to godliness, consideration will easily prove, through a not very indirect train of reasoning, that much of the drunkenness of a population may be traceable to the circumstances of human beings not having good water to drink. We say "good water" rather than "pure water" for a reason. The word pure, if used in this case, must needs be misapplied. Nature does not furnish us with pure water, and, if she did, such water would be absolutely unfit to drink. Another objection would lie against it: pure water, as is well known, has a rapid action on lead, which, being taken into the system, would soon establish a most fatal train of consequences. Consideration of this Fact shows that the public, in clamouring for pure water, should distinctly know what it is about. Even rain water is sufficiently pure to have a rapid action on lead, whereby it cannot be safely passed through lead pipes or stored in lead tanks, and many natural surface waters are in the same category. It is a curious though easily explicable fact that, speaking in a general way, the more impure the water the more amenable it is to lead transit and lead storage. To this rule there are indeed some exceptions, but so few that for general purposes they may be disregarded. Practically, water impurities may be divided into mineral and organic. The former

constitute what is popularly known as hardness, and in respect to them the general belief is that they do the human constitution no harm. We should like, however, the doctors to reconsider their dictum, which, taken without some limitations, must either be untrue, or, if true, shows that experiments conducted on graminivorous animals afford no certain guide whatever for man. Every person accustomed to horses and horned cattle well knows their preference for soft water, that is to say, the chemically purest samples of water furnished by nature. Mere floating particles mechanically suspended in water can be filtered away, and count for nothing in respect to hardness.—*The Engineer.*

DR. NORMANDY'S PATENT MARINE AERATED FRESH WATER APPARATUS.

This invention has for its object the production of pure aerated fresh water from sea water or other undrinkable water, and is one of those which may be of incalculable value at sea and in special circumstances of distress, such as those attending the castaways of the *Megæra.* None but those who have undergone the tortures and perils of unquenchable thirst, in the desert or at sea, can fully appreciate the inestimable benefits conferred by a continuous supply of potable water; of the two the evil of thirst at sea is of the greater magnitude, owing to the boundless extent of the fluid but useless element, "water, water everywhere, but not a drop to drink;" and hence it is at sea that such an apparatus as this is of the most service, so that it should be an essential part of the outfit of every ship.

The advantages claimed for the apparatus constructed upon Dr. Normandy's principles over other machines are, greater economy of fuel and the perfect quality of the fresh water produced.

They are made of three kinds, called *Single Distillation, Double Distillation,* and *Treble Distillation,* and of all sizes, up to 10,000 gallons per day, all of which distil equally perfect fresh water, as agreeable to the taste as any pure spring water, but vary in the consumption of fuel required for a given yield of fresh water.

With a given boiler and a given weight of fuel, the *Double* and *Treble* arrangements have been found to produce from $1\frac{3}{4}$ *to* $2\frac{1}{4}$ *times as much water* as any other condenser; and with a good boiler one ton of good coal will yield with these condensers from 3,100 to 4,400 gallons of pure fresh water.

It is known that 100 volumes of the air held in solution in water contain from 32 to 33 volumes of oxygen, whereas 100 volumes of ordinary atmospheric air contain only 21 volumes of oxygen. Again, ordinary atmospheric air contains only 1-4000th part of carbonic acid, whereas the air held in solution in water contains from 40 to 42 per cent. of carbonic acid.

The fresh water produced by this apparatus is filtered, refrigerated, and aerated with the superoxygenated air and car-

bonic acid gas naturally contained in the sea water operated upon, and it is therefore brisk, wholesome, cold, entirely free from organic matter, and immediately fit for drinking.—*Mechanics' Magazine.*

HEATING BY STEAM.

AMONG the many improvements in cities which the enforced re-building of Chicago has suggested is that of heating the entire town with steam in a manner very similar to that by which it was formerly lighted—by means of pipes running underground from some central reservoir to each house, thus doing away for ever with the annoyance caused by bad coal, damp wood, kindlings, &c. It may be doubted whether the time is ripe for so extensive an improvement, but when we remember that steam may be forced through these pipes to an immense distance, with a very slight diminution of heat, and at the rate of seven miles per minute, it does indeed seem as if the day could not be far distant when a practical application shall be made of what has long been theoretically admitted.—*New York Times.*

INTERMITTENT FILTRATION.

MR. BAILEY DENTON'S system of downward Intermittent Filtration has been tested at Merthyr. The local paper remarks on the subject:—"The public are by this time aware that the system of purification adopted on the land below Troedyrhiw is not irrigation, but a scheme devised by Mr. J. Bailey Denton, the engineer appointed by the Court of Chancery,—which he calls intermittent downward filtration. Twenty acres of land have been parcelled out into four panels of equal areas. The whole piece has been drained to a depth varying from four to seven feet, the drains serving the double purpose of collecting and carrying off the subsoil water and the sewage water. The surface of each panel has been carefully prepared for the equable distribution of liquids. The sewage, after being turned on to the land, is left to find its way by percolation or filtration to the drains beneath, the theory being that in its passage through such a depth of soil, by the time it drops into the drains it has become thoroughly purified—all its offensive solids being left behind, and the noxious elements held in solution being decomposed and absorbed by the deodorising power of the soil, of which the sewage is thus made the incessant fertiliser. The Commissioners first visited the adit of the sewer where the sewage is discharged into the distributing conduits, and half-hourly samples were taken for subsequent analysis. There was only a slight smell as the sewer was opened, and as the sewage flowed over the soil it disappeared, there being an entire absence of odour in walking round the beds. The crops now growing, consisting of turnips, mangolds, cabbages, savoys, Brussels

sprouts, broccoli, and winter greens of various kinds, were really of magnificent growth, and excited the greatest interest in the visitors, who mentioned a Fact of which it is to be hoped that somebody in this neighbourhood may take advantage, namely, that the sewage farms near London not only supply their own neighbourhoods with cabbages, but find a market for tens of thousands of them in Birmingham, and even send them so far as Manchester. After traversing the grounds, the Commissioners arrived at the outlet of the subterranean drains, where there was a large volume of the clearest water flowing, an undeniable proof of the efficacy of the system. Samples of the water were taken at half-hourly intervals for analysis. It was said that the labourers on the ground quenched their thirst regularly at this stream, and by way of showing their faith in its purity, many of those present *tasted* the water, which has a very strong chalybeate flavour and certain indications of the presence of iron. But Dr. Paul has already analysed it, and says in effect that it would be a boon to the Londoners if they could get drinking water of equal purity. To look at it, one might lay a wager that clearer water never flowed in the Taff."

BREAKWATERS.

A LITTLE examination into the duty that a Breakwater has to perform will serve to indicate how very disproportionately great are the means employed to attain the end. As the name implies, the duty of a structure of this kind is to break the force of the waves, and to destroy their violence, so that while there is rough water on the seaward face there may be smooth on the landward. In a word, the object of a Breakwater is to annihilate the impactive and destructive force of waves of translation. All waves may be generally reduced under the category of waves of translation and waves of oscillation. The latter move nearly altogether in a vertical plane, or exert little or no force against objects in a horizontal plane. Experience and observation have ascertained that waves of translation are, comparatively speaking, superficial, and have an average depth of from 12 ft. to 15 ft. This Fact has been well exemplified by the contours which a sea wall, built upon the *pierre perdue* system, assumes under the unimpeded action of the water. For a depth of 12 ft. or 15 ft., that is, so far as the limits of waves of translation extend, the form the loose materials take is that of a long gentle slopé, indicating the transporting or horizontal progressive power of the water. But directly this limit is reached, the materials alter their angle of inclination, and approach considerably more to the perpendicular, proving that motion, in the vertical plane only, is succeeding to that formerly existing in the horizontal There is no doubt that this difference observable in the contour of the sea face of a Breakwater suggested the idea of combining the two systems in the construction, and of forming the lower portion

or foundation of loose rubble stone, and the upper of nearly vertical walls. The latter form is adopted in all cases where stone is scarce or dear; for, although the cost of labour is much greater than in the *pierre perdue* system, yet this is more than compensated by the comparatively small amount of material required. In one sense the vertical, or nearly vertical, wall will constitute a stronger structure than that built of *pierre perdue*, as it must of necessity exert a far greater resistance to the force of the water than will be required of a wall which simply opposes the same force by allowing it to expend itself gradually under a feeble opposition.—*The Engineer.*

THE WOLF ROCK LIGHTHOUSE.

MR. DOUGLAS, the engineer of the Trinity House, has described the erection of the latest of our lighthouses, constructed by the Corporation of the Trinity House on the Wolf, a dangerous, rugged porphyry rock, about 9 miles south-west of the Land's End, exposed to the full force of the Atlantic, and overflowed by the sea at high water. The *Cornish Telegraph* gives a report of the lecture, from which we quote.

Since the year 1795, several very strong iron beacons had been swept away by the violence of the sea, and the corporation determined to erect a lighthouse. In 1860, the design was furnished by their engineer, the late Mr. James Walker, and its execution was first undertaken by the speaker and his brother William, who succeeded him as resident engineer in October 1862. On July 1, 1861, Mr. Douglas commenced his first survey; and, on returning to the vessel that same day, was hauled on board through the surf by a line fastened round his waist, a mode of embarking frequently afterwards resorted to. The cutting-out the foundation began on March 17, 1862 Only 22 landings and 83 hours' work could be done during that year.

In succeeding years more frequent landings and increased working time were obtained, and at length, on July 19, 1869, the last stone of the tower was laid by Sir Frederick Arrow, the deputy master of the Trinity.

The exact height of the tower is 116 ft. 4¾ in. Its diameter at the base is 41 ft. 8 in. It is built of granite, each face stone being dovetailed horizontally and vertically, and secured by strong bolts of yellow metal. The stonework was prepared at Penzance, and conveyed to the rock in barges by means of a steamer; and, in the latter portion of the time, the blocks were lifted into their position by a steam winch, probably the first employment of steam power upon a tidal rock. A fog-bell weighing 5 cwt. is fixed on the lantern gallery.

The lantern itself was constructed by Messrs. Hodge, of Millwall, and in its construction Mr. Douglas was very much assisted by the advice and assistance of Professor Faraday, the scientific adviser of the Trinity House, and his successor, Professor

Tyndall. The optical apparatus was designed by Mr. James T. Chance, and the plate glazing was supplied by the Messrs. Chance. The light, exhibiting alternate flashes of red and white at half-minute intervals, is of a purely distinctive character, being a dioptric light of the first order; the arrangement being adopted after experimental observations by Professor Tyndall and Mr. James Douglas. The illuminating power of each beam is estimated at 31,500 English candles, or units of light.

On the first day of the year, 1870, the light was first exhibited.

The average number of persons employed in this work at one time was about 70, and no instance of loss of life or limb occurred to those engaged. The total cost of the erection was 62,726*l.* The tower was erected in 809½ hours (only 101 working days of eight hours each). 266 landings were made in seven years. It contains seven rooms, adapted for living, sleeping, stores, and apparatus.

Since the completion of this lighthouse, no shipwreck has occurred on the shores of Mount's Bay, or in the vicinity of the much-dreaded Land's End.—*Builder.*

MONSTER BLAST AT GRANITE QUARRIES.

It is estimated that 80,000 tons of rock have been thrown down by one blast at the Bonaw Quarries, near Inverary, in Scotland. Preparations had been in progress during eighteen months for this great blast. A rough protecting house was formed for the battery at a point 100 yards from the mouth of the mine, and on the same level as the quarry floor, along which the conducting wires were laid till they formed a junction with the battery near to the site of the quarry at the shipping quay. From this point Mr. Sim, of Glasgow, the proprietor, crossed Loch Etive to the Goat Island—200 yards distant—with the working cords of the battery. Here he found a desirable place for shelter from flying stones. From his position he was also enabled to obtain a near view of the working of the blast. In the firing there was no report or noise, merely a silent heaving of the mountain, bursting and pressing forward innumerable pieces of rock from the formations in which they had existed in their natural state. The quantity of rock displaced is enormous, being computed by measurement at 80,000 tons, constituting this blast the largest and best which Mr. Sim has had during his 18 years' experience of this peculiar system of blasting.—*Builder.*

THE HARVEY SEA TORPEDO.

The Torpedo question has of late become a very large one, owing to the active part taken in its solution by all maritime nations. America has perfected a system of torpedo boats and gear, which is reported to be very complete and efficient. Prussia

is at present engaged in improving its torpedo service, whilst Russia is arming her naval forces with the weapon which forms the subject of the present notice. At home, our Royal Engineers have brought submarine torpedoes, as applied to coast defences, to a high state of perfection. Prominent among these is the invention of Captain John Harvey, R.N., who for more than 20 years past has endeavoured to convince successive Governments of the absolute necessity of having an arm of this description which should be at once effective and reliable in working and handy in use. A nephew of the inventor, Captain Frederick Harvey, R.N., has interested himself in the weapon, and has had it in hand for several years past, having brought it to its present form. The torpedo consists of a stout wooden casing, strengthened on the outside with iron straps, and containing a metal shell which holds the powder charge. A central transverse section of the weapon gives a rectangle, while in plan it is a rhomboid, the ends being angled to give the torpedo, when towed, a divergence of about 45 deg. from the vessel towing it. The torpedoes are of various sizes, according to requirements, the large size weapon measuring 4 ft. 6 in. in length by 2 ft. in depth and 6 in. in width. The charge for this torpedo is 76 lb. of gunpowder or 100 lb. of dynamite or litho-fracteur. The charge is inserted in the casing through two holes, which, after loading, are first secured with corks, and then with screwed brass plugs.

The torpedo is fired by being brought into hugging contact with an enemy's ship, when one or other of two projecting levers acts upon an exploding bolt, causing the ignition of the charge. The exploding apparatus consists of a tube containing a chemical agent and a bulb holding another. The nature of these chemicals is such that when they combine violent combustion ensues, which explodes the charge. In operation the pressure upon the lever forces down the bolt, the bottom of which presses upon a pin in the lower part of a brass tube. At the bottom of the exploding bolt is a specially prepared composition, and the bulb containing an acid. The puncturing of the bulb frees the acid, and the combination of the chymicals effects the explosion. The composition embodies certainty of action when combined with acid and great explosive power. The highly dangerous character of this torpedo demands that every precaution should be adopted to insure the safety of the operators. Captain Harvey has, therefore, devised a safety key, which is inserted through the stem of the firing bolt, and attached to a line coiled inboard. When the weapon has been floated out clear of the operating vessel the key is withdrawn by slacking the tow rope and holding on to the safety-key line, by which means the key is withdrawn and hauled on board.

A small quick-speed vessel is used in operating the Harvey torpedo, and from it the weapon is launched. The tow-line is payed out from a drum fitted with a strap-break, the safety-key line being run out from a small winch. The torpedo on being

set afloat at once diverges at an angle of 45 deg. from the ship, and is thus readily towed against an enemy's vessel. The form of the torpedo and an arrangement of slings in connexion with it enable the operator to cause the shell to diverge alongside the enemy's ship in meeting, passing, or crossing, whichever method of attack is adopted. The angle of divergence of the torpedo from the line of progression of the vessel towing it is due to the vertical plane of the torpedo being thrown at that angle by the manner in which it is slung. Two buoys are attached to the large torpedo and one to the small one, and these are sufficient to insure the floating of the weapon at any given depth. They are attached to the tow line, on the farther side of a thimble to which the slings are made fast. The tow line passes through the thimble and the buoy rope to a large eye fixed to the upper part of the torpedo. By means of this arrangement the torpedo can be cut adrift should the necessity arise. The tow line being severed on board the torpedo vessel, the weapon would at once sink, the line running through the thimble and the eye, and being attached to the buoys, could be afterwards recovered. Such an emergency might arise in practice from the towing vessel having suddenly to cross the line of the torpedo, and the danger of contact would be avoided by thus cutting it adrift.

Such is the Harvey torpedo with which experiments have been made in the Yarmouth Roads, conducted by Captain Harvey. The torpedo vessel upon this occasion was the *Andrew Woodhouse*, a small paddle-wheel tug-boat of about 70 tons burden, in which a temporary arrangement for towing the torpedoes had been improvised. This consisted of a jurymast rigged up abaft the funnel of the tug, and to which a yard had been made fast. Two torpedoes were used—a small one, which was operated from the port side, and a large one which was worked from the starboard side of the vessel. The small one was filled with water to give it a weight approximating to that which it would have when charged with explosive material, the large one being a dummy, as used in training practice. Both weapons were fitted with exploding bolts, so that the fact of the firing action having come into operation might be placed beyond a doubt. The tow lines were both of wire rope, that of the small torpedo being a three-quarter inch, and that of the large one a 1½ in. rope. The *Andrew Woodhouse* steamed out into the Yarmouth Roads, and the large torpedo was at once launched. There was a strong breeze blowing and a moderately heavy sea on, which afforded an opportunity of showing that the torpedo could be worked in bad weather. The first attack was made with the large torpedo on a brig under sail, by coming down from right ahead and passing at a great speed—from 9 to 10 knots. The tow-line was skilfully dipped under the vessel, and the torpedo brought into hugging contact with her bottom amidships. The strain brought upon the main yard by the contact of the torpedo caused it to be carried away; not, however, before the torpedo had done its work,

for on recovering it the levers were found to be down and the exploding bolt driven close home.

The next attack was made with the small torpedo, in the same way as the previous one, against a brig in full sail. The line was successfully dipped under the vessel, but when the breaks were put on, the wire rope, being stranded, carried away beneath her keel, the torpedo coming up on the off side of the ship. The parting of the wire rope was easily accounted for by the fact that it had been used many times previously in similar experiments, and had, therefore, become somewhat damaged, the weak place making itself known directly the strain was brought upon it. The attacks in both cases were splendidly made, and the distinguished officers present expressed themselves perfectly satisfied with the torpedo and its working. Other attacks would have been made, but as none but small vessels hove in sight—which were not considered fit subjects for attack for the reasons we have already given—and as everyone was perfectly satisfied with the results of the experiments, the ship's head was put about and she steamed back into harbour. No hitch or mischance occurred to the gearing of the torpedoes, except the breaking of the old wire rope of the small weapon, while the carrying away of the main yard only served to develope a sailor's resources under such circumstances. Considering that the practice was made in rough weather, with a temporary mast and hastily-improvised spar, and that Captain Harvey had only the assistance of men who had never seen the torpedo before, the experiments can but be considered as a thorough success. They serve to demonstrate very forcibly the seamanlike nature of the torpedo, the gear and working of which adapts itself at once even to untrained hands.—*Abridged from the Times.*

HYDRAULIC BENDING MACHINE.

A VERY large casting has been made at the works at Cubitt Town of Messrs. Westwood, Baillie, and Co., for the cross-head of a very large and powerful Hydraulic Machine for bending iron armour plates in Pembroke Dockyard. The casting weighs in the rough 28 tons 9 cwt., and the metal was melted in two cupolas. The bed plate is of cast iron, sufficient in strength to stand the test of 4,000 tons. The four columns are forged from the best scrap iron, and as turned with the screw thread for the nuts to screw over are 13 in. in diameter. The distance between them will be 7 ft. The cross-head itself is 11 ft. 4 in. by 5 ft., and 4 ft. 8 in. deep, with three cores running through it, and will be supported by four nuts, 21 in. diameter and 10 in. thick, so that it can be raised or lowered to any required height. The cylinder is 40 in. in internal diameter, and its walls $7\frac{3}{8}$ in. in total thickness. It is formed of a thin inner ring of wrought iron, surrounded with thick rings of cast steel. It will be fitted with a cast-iron ram of the like diameter, and there will be a

small gun-metal hydraulic attached to the large one to move the cylinder from one side to the other. The centre ring of the great cylinder is formed of a wrought-iron plate, 4 ft. 10 in. square, and 5 in. thick, projecting about half-an-inch beyond the outer rings, so as to form a bearing for the guide plate to prevent it from canting. The pumps are four in number, of gun metal, with very strong gear. Two are of 1 in., and two are of 2¼ in. diameter, being respectively worked from a strong eccentric shaft, and so arranged that only one pump exerts pressure on the ram at the same time. They will be driven by span wheel and pinion, the wheel being fitted on the eccentric shaft, and the pinion and a small fly-wheel on the intermediate shaft, on which are fitted the fast and loose driving pulleys. The diameter of these pulleys is 18 in., and the speed at which they will run will be 200 revolutions per minute. The weight of the whole machine will be about 80 tons.

HYDRAULIC APPARATUS.

HYDRAULIC Apparatus has been introduced into many manufactories to lighten manual labour. In ironworks it is employed to drag the mass of welded iron from the furnace, so that it may be transferred to the hammer or the rolls; and in the Bessemer process for the manufacture of steel it is employed to move the cranes and other apparatus. Recent advices from Paris announce that it has been introduced into one of the theatres there for shifting the scenery, the motion when necessary being accelerated by the intervention of pulleys.

DRYING WOODS.

THERE has been read to the Belfast Natural History Society, by Dr. James Thomson, a brief communication upon the Shrinking and Warping of Woods in Drying. He turned attention especially to the distinction between—firstly, splitting and warping caused by unequal shrinkage at different parts of the same piece of timber; and, secondly, splitting and warping caused by unequal shrinkage in different directions in the same part. If the circumference of a tree shrink more than the central core, many longitudinal cracks are liable to occur at the outside without penetrating to the centre. If, on the other hand, a single crack alone is found to open from the circumference to the centre, leaving a wedge-shaped vacuity, the crack being so formed that its width at different distances from the centre increases about exactly in proportion to the distance from the centre, then the distortion is to be attributed to a greater shrinkage along the circumferential direction of the annual rings of growth, rather than along the radial direction of the medullary rays. In such cases the one radial crack, or a radial or a diametrical saw t, may give perfect relief to the severe strains which,

in the absence of any crack or cut, would arise during drying. By shrinkage more or less exactly in this way, the very frequent tendency of boards to warp so as to become convex on the side next the centre of the tree, and concave on the side next the bark, is truly accounted for. Professor Thomson having given explanations of this line of reasoning, and shown examples of various kinds of shrinkage and warping, mentioned that he had found these conditions misconceived or overlooked in some of the best treatises, and frequently so among practical men, and hence it was that he brought it before the Belfast Society. He referred, however, to an article on "Joinery" in the *Encyclopædia Britannica*, in which he had found the subject well discussed and explained in its main aspects.

DYEING HAIR.

An ingenious instrument for Dyeing Hair has been invented in America. It consists of an arrangement like a large pair of scissors; but one blade consists of a hollow cone, like an extinguisher, and the other of a flat plate, which shuts up against the side of the extinguisher. Within the extinguisher a piece of sponge is fitted, and an oblong hole is cut in the side of the extinguisher where the flat plate comes in contact with it, through which hole the sponge slightly protrudes. The sponge is now saturated with the dye, and the hair is drawn through between the flat plate and projecting sponge, whereby it is dyed without any of the dye being spilt upon the skin.—*Illustrated London News.*

FORCING HOUSES.

At the time when vineries, started at the ordinary season, are carrying crops busily engaged in the hard-taxing process of stoning, the better to ease them over this trying period, keep the structure at a more moderate temperature for a little time previously, and so allow the roots to fetch up any arrears of supply demanded. Too frequently a hurried stoning process becomes the precursor of future decrepitude, causing in some degree the horrid shanking malady so much to be dreaded in all instances where the roots of the vines are not under the most perfect control of the cultivator. At such a period root water should be given freely if the border be within doors. Give air to all grapes when colouring with tolerable freedom by night when the weather is mild Continue to shift successively the most forward successional pines, as in this operation lies the groundwork of a future constant successional supply of fruit. Encourage all pines to make a rapid growth, as the sun's warmth and light will conduce to the formation of fine-developed fibre. Endeavour at this season not to overcrowd them; but, by allowing each abundance of room, endeavour to attain a stiff, sturdy framework. Though cherries shall have produced all

their crop, it is not judicious to cease watering them too quickly; rather afford abundance to the roots, for the purposes of root and bud formation. In many instances when melons are ripening their fruit, take care to gather them before they become too ripe; as by leaving them too long afterwards the flavour is lost, and full maturity of the fruit hastened, which involves earlier decay. Attend carefully to the root-watering of figs, on which are fruit in a young state. If in any instance red spiders have gained a lodgment in peach and nectarine houses during the last stages of the fruit's ripening, have resort, immediately the fruit is all gathered, to heavy fumigations; for though the crop has been gathered for the current season, the house has yet to be, as it were, the laboratory for perfecting the wood for the next season's crop. Even the roots, it is possible, in some instances, may need watering.—*The Gardeners' Chronicle.*

NEW SYSTEM OF LIGHTING.

A PAPER has been read by Mr. Silber, before the Society of Arts, on a method of lighting towns, factories, and private houses by vegetable or mineral oils. The system proposed is to distribute the oil over the house in pipes, like water, from a general reservoir containing a few gallons at the top of the building. The flow is regulated by little cisterns provided with a novel and well-constructed tap, regulated by a ball-cock or self-acting float, the lights being as nearly as possible on a level with the distributing cisterns. When the lamp is lighted, the oil is by the ball-cock movement supplied automatically as fast to the wick as it is consumed, and a very perfect combustion is effected. Numerous lights, of excellent quality and steadiness, were kept burning in the lecture room during the evening; and on the long and earnest discussion which followed there was a general concurrence in admitting the great advance which had been made in this mode of burning light petroleum oils. There was none of the unpleasant odour so common to all the previous mineral oil lamps.

LONDON GAS.

FROM a Report by Dr. Letheby, the chief gas examiner appointed by the Board of Trade to the Corporation and the Metropolitan Board of Works, on the quality of the gas supplied by certain companies during the quarter, the average illuminating power of the gas of each company at the several testing places is as follows:—When burnt at the rate of five cubic feet an hour, the common gas of the Chartered Company has been equal to about 17·14 standard sperm candles. The Imperial Company's gas has been equal to about 16·4 standard sperm candles; and the South Metropolitan Company's gas has been equal to 16·16 candles. The cannel gas supplied by the Chartered Company to Cannon Street has been equal to 27·92 standard sperm candles.

With respect to purity, Dr. Letheby reports that the gas of all the companies has been free from sulphuretted hydrogen. Sulphur in other form than this was present in the gas of the several companies in very variable proportions. In most cases the proportion of sulphur had been larger during the quarter than in the corresponding quarter of last year. Ammonia was not in any case in excess of the quantities prescribed by the referees.

At the annual meeting of the London Gas Consumers' Association, a paper compiled from Parliamentary documents was read by Mr. Flintoff, their engineer, from which it appears that the gas consumed in the district of the Metropolis Gas Acts last year was 10,908,069,000 cubic feet; its illuminating power equal to 16 sperm candles; its cost to public and private consumers 2,045,262*l*. 19*s* 9*d*., and for public street lamps alone 226,680*l*. 12*s*., while the quantity of coal used in its manufacture was 1,363,508 tons.

GAS IN JAPAN.

THE growing inclination on the part of the Japanese to introduce, both in their social and political affairs, some important features of our Western civilization, has lately been attracting attention in this country. One item, which indicates to some extent this desire of the Japanese to keep abreast of the times, is not yet generally known. This is the introduction of Gas, which will shortly be made in the principal commercial town of Japan—namely, Yokohama, and in part of the city of Yedo, the seat of the Mikado's Government. The contract for the construction of the works required in this undertaking has been negotiated through the medium of Messrs. Miller Brothers, Glasgow, and has been intrusted by them to Messrs. Robert Laidlaw and Son, gas engineers, of that city. The portion of the works, comprising about one-fourth of the entire undertaking, was first completed. The plans have been prepared by a French engineer, and the erection and management of the works will be conducted under his personal superintendence, while the labour will be performed by native Japanese workmen. The company is named the Yokohama and Tokio Gas Company.

A NEW FIRE-ANNIHILATOR.

A PATENT has been applied for in Belgium for a new chemical liquid composition, destined to extinguish fires, by Mr. M. F. Rommel, of Molenbeck-Saint-Jean—the following is the description: Pour in a wooden vessel, lined with lead, 100 kilograms of chlorhydric acid saturated with lime. Add 40 kilograms of a saturated solution of ammonia-salts, and 40 kilograms of a saturated solution of borate of soda. When these substances, after having been well mixed, have settled sufficiently, the clear

liquid is decanted and concentrated to crystallisation; and the substance so obtained is then employed by pouring it in the water used to extinguish fires, in the quantity of 10 kilograms per hectolitre for the first five hectolitres, and subsequently five kilograms per hectolitre, which will be found sufficient.—*Mechanics' Magazine.*

A ROAD STEAMER.

There has been read to the British Association, a paper "On a Road Steamer," by Mr. R. W. Thomson. The great feature in the construction of this machine is the use of a very thick india-rubber tire, to the outer circumference of which is attached a chain of flat plates of iron. These india-rubber tires not only completely prevented hard shocks to the machinery, but saved the road from the grinding action of the iron wheels which was so injurious to by-ways. There had been serious objections made to the use of these engines with rigid tires, but the author could assure them that the india-rubber tires not only did not injure, but actually improved the roads. The only ground upon which india-rubber tires did not work well was where the soil was extremely wet, or of a very soft and sloppy nature. For farm work, the wheels of the engine required a much thicker coat of india-rubber.

Mr. Smith said he believed that, next to railway engineering, there was scarcely a question of so much importance as that of the application of steam-power on the common road. Persons interested in roads especially were prejudiced against road steamers generally, but, as was demonstrated in the paper, a properly constructed traction engine, of the kind spoken of by Mr. Thomson, would rather improve than injure the roads. Mr. Bramwell, after referring to the general construction of Mr. Hancock's steam-carriage, which was in use for regular passenger traffic in the New Road, in London, some years ago, said they ought not to ignore what that gentleman had done with rigid tires. India-rubber tires, however, exercised a tractive force which they did not know of in any other substance. They had in them a flat-bearing substance coming in actual contact with the road, and thereby taking off materially the jar on the machinery. Mr. Meik said he had also seen the steam-omnibus lately running on the Portobello Road, but it seemed to him to be before its time, the roads were so bad. He believed that until the roads were kept in better condition, such engines would never be successful. He afterwards spoke of the importance of applying steam-power on the roads, and hoped that, though the tramways about to be introduced in Edinburgh would be worked at first by horses, small locomotives would soon be employed. Mr. R. Douglas stated that Mr. Bartlett, of the North British Rubber Works, had invented an india-rubber tire built in small staves, which he said was a great improvement on the expensive

continuous tire. The President said Mr. Thomson had never claimed to have introduced traction engines; he claimed to have introduced an india rubber tire, and thereby effected an important improvement. He (the speaker) had watched the application of india-rubber tires to the road engines. A good traction engine without india-rubber tires would work well on a good ground, but failed on soft ground, and would injure roads that were not well made; whereas the traction engines with india-rubber tires worked well even on soft ground, and did no injury even to bad roads.

A NEW CAMPAIGN KITCHEN.

THE *Precurseur* gives the following description of a new addition to camp equipage, which is now being tried in several of the camps near Paris:—"It is an artillery wagon drawn by one horse and driven by a soldier of the Military Train. The wagon contains two large saucepans, one for making soup and the other for coffee. The cooking is done by steam, and is not interrupted when the wagon is in motion. Each saucepan has a tap by means of which the soldiers at the proper hour fill their pannikins. Each wagon is fitted to supply a company."

LITHOFRACTEUR EXPERIMENTS.

A SERIES of important experiments has been recently conducted at the quarries of Mr. France, near Shrewsbury, with the view of testing "lithofracteur," an explosive which has been used for some time by Prussian military engineers. Two points were sought to be determined by these experiments. 1st. If the substance is really a good blasting agent; and 2nd. If it can be carried safely by rail or other means of conveyance. The exact composition of lithofracteur is not given by the manufacturers, Messrs. Krebs, of Cologne, but it is stated that "it contains, like dynamite, 75 per cent. of nitro-glycerine, differing from that compound, which contains 25 per cent. of fine sand, in having the nitro-glycerine taken up and rendered innocuous by admixture with other substances of explosive power, and with a smaller percentage of infusorial earth." The experiments commenced by burning and throwing about cartridges containing about $1\frac{3}{4}$ oz. of lithofracteur, the object being to show that the substance is not explodable without the application of a fulminate fuze, and that under mere ignition and under ordinary concussion it will be either unaffected, or will simply and harmlessly burn away. It was then employed in blasting in different parts of the quarry, with very satisfactory results, the effects produced being generally considered, by those present, as impracticable with gunpowder. The explosive was then subjected to the test of a railway collision on a long and very steep line, down which the wagons from the quarries run to the mineral traffic line.

The incline of the tramway is 1 in 8, and several old wagons, weighing about 1½ ton apiece, and having a 2 oz. lithofracteur cartridge attached to each buffer, were sent down a length of 500 yards against another blocked up on the line. Cartridges were also placed on the rails for the descending wagon to pass over. The lithofracteur stood these tests with perfect success. Subsequently, its power in snapping iron rails was exhibited, and the experiments concluded with a subfluvial explosion in the river Severn, a raft being blown to pieces by a submerged charge, and some dozens of fish killed and sent floating down the stream. The trials were considered, by the majority of those present, to be on the whole satisfactory.—*Mechanics' Magazine.*

CUTTING, ENGRAVING, AND BORING HARD STONES AND METALS BY JETS OF SAND.

MR. C. TILGHMAN, of Philadelphia, engineer, has discovered that, with a jet of sand blown through a pipe by steam, at 300 lb. pressure to the square inch, he can make a hole in a solid block of corundum, an inch and a half deep and of the same diameter, in less than 25 minutes. Corundum is little, if at all, inferior in hardness to diamond. Mr. Tilghman turns upon corundum a pipe which discharges sifted sand, mixed with a furious squirting of steam; and the fine shower of particles thus flung cuts a hole equal to the diameter of the jet, the same effect being produced in anything else submitted to the same process, thus effecting what is desired in a tenth of the previous time, and with exquisite precision. But the discoverer of the new agent has also found that so great a force as steam is not necessary for finer work, such as grinding or engraving glass, a blast of air being sufficient for this, by means of a rotary fan. The tube is fitted with sifted sand, which the air takes up and whirls against the glass. It will thus completely depolish a surface moving past at the rate of 5 in. per minute, and the spent sand and glass dust can be perpetually returned and re-employed.

By covering parts of the glass with any semi-elastic material, such as paper, lace, caoutchouc, or oil paint, designs of any sort may be engraved. The articles which eat off the hard glass or stone beat in vain upon the interposed medium; and so curious is this resistance, that even a green fern-leaf may be used, and the sand-shower will consume all but the parts thus covered, leaving a delicate pattern of the frond. Again, in that kind of glass-work where a sheet of one colour is superimposed upon another, the upper sheet may be partially protected by a paper stencil, while the parts left exposed are eaten or bitten away into the desired figures. The film of bichromatised gelatine used for photographic negatives may also be thus utilised for producing an engraving on glass or steel; and by a very

simple arrangement the jet can be rendered movable and handled with an absolute artistic freedom.

So effective, indeed, is this principle of minute myriad tapping upon any exposed surface, that small leaden shot driven in the same manner wear a hole in the hardest quartz rock. The exhibitor of the new agent showed at Philadelphia a sheet of glass which had been perforated by the sand-jet, under a covering of wire gauze. The glass was turned, as it were, into a delicate square of blonde lace, with meshes of $\frac{1}{12}$ in., and threads of $\frac{1}{16}$ in., a result unattainable by any other process.

When rougher work is called for, the inventor employs the steam pipe at high pressure, with a force of 125 lb. to the square inch. The sand, conveyed to the steam through a $\frac{3}{16}$ in. concentric tube, is sucked into the blast, and, being discharged upon a surface at 1 in. distance, it will eat away per minute, with its tiny, but sharp teeth, $1\frac{1}{2}$ cubic inch of granite, 3 cubic inches of marble, and 10 of soft brown sandstone. At a still higher velocity, nothing can resist the sand-squirt. With only a limited pressure, in ten minutes, the inventor drilled a hole 1 in. long by $\frac{1}{4}$ in. wide, through a hard steel file, $\frac{1}{4}$ in. thick; and corundum is cut through almost like cheese.

Certain mechanical phenomena in connection with this ingenious application of the commonest principles are especially curious. If, for instance, templates of brass or sheet steel be laid over the surface operated upon, they curl up, and, as it were, wither away under the impact of the sand-shower; hence, paper, gum, or even the delicate leaf of a plant, or the finest lace, is more durable for a shield. Fine lace will guard the glass from the sand, and leave its pattern accurately marked in polished lines and spaces, so that this new method promises in every respect to supersede the slow process of engraving by fluoric acid or by the emery wheel.

Stone-carvers know that many hard materials, such as granite, are very much injured—"stunned" is the technical phrase—in the process of being hand-dressed. By the sand-squirt, however, everything is done neatly and perfectly, without any damage to the face of the material; and one would almost think that the Egyptians who produced such admirable intaglios knew some process resembling it.

Where the sand and steam impinge upon stone under high pressure a red glow is visible, the result, it is supposed, of intense disintegrating action, like the flash of light which appears when heavy shots strike upon an iron target. An inquiry into the electric, caloric, and especially the diamagnetic stamp and relationships of the substance operated on might prove instructive as well as interesting.

It is needless to point out the many uses to which the new agent may be applied. Every practical engineer will at once see that, instead of a chisel, or stamper, or punch, or drill, perpetually to be renewed, he has here the idea of a cheap and

by passing air through the mass, as in Bessemer's process, and the impurities by washing them out with molten slag. The present rude process of puddling is one that cannot long survive in the face of the numerous improvements in the iron manufacture which are now being made.

A new puddling and reheating furnace, called Howatson's furnace, has been introduced into some ironworks with satisfactory results. Its peculiarity consists in the application of an air-jacket around the furnace, through which jacket the air passes on its way to the ashpit; and the opening to the ashpit is formed with doors, usually kept close, but which may be opened for the removal of the ashes, so that the air may be constrained to pass through the jacket by the action of the draught. Such a furnace was introduced at Cwm Avon, near Swansea, a year ago. The advantages alleged are, that it saves one-fourth of the coal and a good deal of the iron, the production of cinder being less and the yield of the iron more than in ordinary furnaces. There is no doubt that this species of furnace is an improvement upon that usually adopted. But we now require a much more radical change in the puddling process than the introduction of such a furnace as this implies.

At a meeting of the Iron and Steel Institute, held at Dudley, under the presidentship of Mr. Henry Bessemer, various subjects of interest were discussed, foremost among which was the automatic puddling-furnace of Mr. Danks, which is said to have been introduced into some of the American ironworks with much success. In this furnace the fireplace is stationary, and it is supplied with air driven in by a fan so as to generate gas, which gas is afterwards burnt by jets of air, also forced in by a fan, so that the furnace is essentially a gas one. The puddling-chamber is made of iron and is of a cylindrical form, so that it may be rotated upon rollers with its axis nearly horizontal. It is open at the ends; but one end abuts against the bridge of the stationary furnace, while the other end has a hood applied to it to carry off the products of combustion. The iron cylinder is lined with a fettling, or layer of infusible substance, composed of a mixture of oxide of iron and lime ground together into a species of mortar. The iron is introduced into this barrel or chamber, which being slowly rotated, the iron is rolled over and over, and finally puddled without the interposition of manual labour. Similar furnaces had previously been tried in this country, and had been unsuccessful mainly from the peeling off

exhaustless self-regulating and irresistible tool, which, with its infinitely industrial impact of atoms upon atoms, does a prodigious work, so to speak, microscopically.—*Builder*.

EXTENSIVE BLASTING.

General Newton, in the work of blasting away the extensive submarine ledge of rocks known as Diamond Reef, situated near Governor's Island, in New York Bay, has, with great ingenuity, overcome the difficulty of drilling submarine rocks from a floating platform anchored above. The use of a cofferdam or a caisson is impracticable at Diamond Reef, in consequence of the violent action of the tides, which sweep away every obstacle. The muddy water also prevented the divers from working, and all other known plans failed completely. General Newton at last devised the following method of operating:—A large and strongly-built scow, 140 ft. long and 50 ft. wide, provided with overhanging guards and lifting apparatus driven by steam, was constructed and moored over the rocks in the exact position, by heavy chain cables, hawsers, and ponderous anchors. In the centre of the scow was placed a well-hole, through which, by means of powerful derricks, an iron dome, 30 ft. in diameter, and weighing 70 tons, was lowered down into the water, where it rested evenly upon the rocks by means of adjustable legs. The divers then descended, and worked under the protection of the dome, directing the steam drills and the other instruments, which are similar to those used in the coal-oil regions. While the water at the surface boils and rages, below the dome the current, although strong, is steady and clear. Each drill is operated by a separate engine, and the agitation of the water washes out the fragments of the rock from the hole. The average progress made in drilling is 1 ft. per hour. For a month the work of drilling Diamond Reef has been going on, and nine holes, each 11 ft. deep and 4 in. in diameter, were bored. Into each of these holes a charge of 30 lb. of nitro-glycerine, enveloped in two-ply india-rubber pipe, 2½ in. in diameter and 7 ft. long, was inserted. A copper wire, 1,000 ft. long, heavily coated with gutta-percha, was attached at one end to a powerful Leyden jar battery, and at the other end was connected with the charges by means of wires and fulminating rods. These heavy charges, forming in the aggregate 270 lb. of nitro-glycerine, were exploded, and the quantity of rock moved corresponded to the immense force of the substance.—*United States Railroad and Mining Register*.

PUDDLING IRON.

Machines for puddling iron have often been tried, but have not hitherto been successful. The last of these contrivances is that of Mr. Griffiths, recently introduced at the Normanton Iron-

works, it is said with satisfactory results. The rabble is moved backwards and forwards in the furnace by machinery in such a way as best to imitate the action of a puddler's hand. We cannot think that this is a method of puddling which will come into general operation, as there is no necessity for imitating the existing mechanical action at all, and it is merely necessary to provide that the carbon and impurities shall be removed from the iron as effectually as possible. The carbon is to be removed by passing air through the mass, as in Bessemer's process, and the impurities by washing them out with molten slag. The present rude process of puddling is one that cannot long survive in the face of the numerous improvements in the iron manufacture which are now being made.

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of the internal lining. But this difficulty Mr. Danks professes to have surmounted. Mr. Bodmer, of Newport, has proposed a different method of puddling. By his plan the molten cast iron is run in a thin sheet between rollers revolving at different velocities, with water within the rollers to keep them cool, and the metal is thus powdered. A proper proportion of oxide of iron is then intimately mixed with the powdered iron, and the mixture is delivered from a hopper on to a succession of slowly rotating rollers which are covered with a suitable coating of infusible material. These rollers are kept at the temperature necessary for puddling by a furnace built over them; and when the iron is delivered by the last roller it is puddled iron. Various other methods of automatic puddling, besides the foregoing, have been propounded, and there is little doubt that some mode superior to the present hand-process will soon be found. In other departments of the iron manufacture improvements are being introduced. A new reversing rolling-mill for steel rails has lately been started at Barrow, the reversing being accomplished by reversing the engines, and the fly-wheel being discarded. In the thirty-ninth volume of the *Revue Universelle des Mines* M. Hovine describes various improvements in rolling iron, which have been introduced in Germany, France, and England; and in Nos. 182 to 184 of the *Portefeuille Economique des Machines* a description is given of Bouniard's hydraulic process for casting metals under pressure, one of the applications of which is to the casting of tires for railway wheels.—*Mr. Bourne: Illustrated London News.*

MANUFACTURE OF FRENCH NAILS.

French Nails are manufactured at Charleville partly in large factories by machinery, partly in a multitude of small factories, or rather ateliers, scattered about the densely peopled villages. These villages, and especially one of them, Neufmanil, are not only inhabited by people, but by an 'ouvrier' class of dogs. The labour of these dogs, whose hours are as exactly regulated as those of their human fellow-labourers, consists in furnishing motive power to the bellows, which fan the furnaces of the ateliers. They get inside a wheel, and turn it, just like squirrels in a cage. There are four stages of each day's labour. The first lasts from 5 to 8 a.m.; the second, from 8 30 to 12 p.m.; the third, from 1 to 4; the fourth, from 4.30 to 7 p.m. Each dog works during two stages only. The early dog, who works from from 5 to 8 a.m., misses the second stage, and is not employed again till 1 p.m. The dog who begins his day's work at 8.30 misses the third stage, being reserved for the fourth. Another peculiar feature of the nailmaking industry is, that each workman or woman belonging to a particular atelier has to furnish a fixed and equal daily supply of fuel to keep the furnace going, which is consumed, whether the individual contributor works or

no on any particular day. As the workpeople are paid by the quantity of nails each produces, the burning of their fuel, whether they work or no, acts as a strong stimulant to continuous labour.—*Mechanics' Magazine.*

THE MANUFACTURE OF RUSSIAN SHEET-IRON.*

A PARTICULAR kind of Sheet-iron is manufactured in Russia, which seems not to have been produced elsewhere. It is remarkable for its smooth, glossy surface, which is dark metallic grey, and not bluish grey, like that of common sheet-iron. On bending it backwards and forwards with the fingers no scale is separated, as is the case with sheet-iron manufactured in the ordinary way by rolling; but on folding it closely, as though it were paper, and unfolding it, small scales are detached along the line of the fold.

This sheet-iron is in considerable demand in Russia for roofing, and in the United States, where it is largely used in the construction of stoves and for encasing locomotive engines. It is there named stove-pipe iron.

Russian sheet-iron has been recently subjected to chemical examination in the Metallurgical Laboratory of the Royal School of Mines, and the analytical work has been executed by Dr. Percy's assistant, Mr. W. J. Ward.

The occurrence of a peculiar carbonaceous mass, left after the solvent action of dilute hydrochloric or sulphuric acid, may reasonably be accounted for, Dr. Percy says, by the method of manufacturing Russian sheet-iron, which he describes. The sheets are interstratified with charcoal-powder, and bound up in packets, each of which is subjected to repeated hammering. Hence it is easy to conceive how fine particles of charcoal should be beaten in over both surfaces of each sheet; and, if this be so, a relatively larger proportion of carbon should exist in the thin sheet, as is the case. Yet that some of the carbon is combined, may be inferred from the fact that distinct hardening occurs after heating the metal to redness, and immersing it while hot in water, and especially in mercury.

In the volume on iron and steel which Dr. Percy published in 1864, he stated that the mode of manufacturing the Russian sheet-iron in question was kept rigidly secret; that it was made from iron smelted and worked throughout with charcoal as the fuel; that, according to information which he had received from three independent sources, the sheets, after the completion of the rolling, were hammered in packets, with charcoal-dust interposed between every sheet; and that they were subsequently assorted, and the outer ones, being inferior in quality, were thrown aside as wasters.

Our author has since found that the *secrecy* was more depen-

* The Manufacture of Russian Sheet-Iron. By John Percy, M.D., F.R.S., Lecturer on Metallurgy at the Royal School of Mines, &c. With illustrations. London: John Murray, Albemarle Street. 1871.

dent on ignorance of the Russian language than on anything intentional; and he now gives various particulars of the process.

The manufacture of sheet-iron in Russia, he says, is chiefly confined to the ironworks on the eastern side of the Oural Mountains. The malleable iron, which is the subject of this manufacture, is derived from pig-iron, obtained by smelting the following ores with charcoal in cold-blast furnaces, namely: magnetine, carbonate of iron (*sphæro siderite*), and red and brown hæmatite. The conversion of the pig-iron into malleable iron is effected either in the charcoal-finery or in the puddling-furnace.

The puddle-balls, intended for the manufacture of sheet-iron, are rolled into bars 5 in. wide and ¼ in. thick. The iron should be more crystalline than fibrous, and should contain sufficient carbon to render it more like steel than iron. The machinery required consists of one or two pairs of rolls and two kinds of hammers. Reheating is conducted in furnaces of particular construction. The rolls are driven by water-wheels, and should make not fewer than 50 revolutions a minute. The hammers are also put in motion by cams on the axles of water-wheels. The hammer heads are of wrought-iron, with striking faces of steel. Each anvil consists of a solid block of white cast-iron. It is necessary that the hammers and anvils should be so made, in order that they may have the requisite hardness, in default of which the surfaces of the sheets would not acquire sufficient brightness or polish.

The puddle-bars, 5 in. wide and ¼ in. thick, are cut into pieces 29 in. long, which weigh about 15·35 lb. avoird. (10 lb.?—J. P.). These pieces are heated to redness, and cross-rolled into sheets about 29 in. square; and in order to become thus extended they require to be passed through the rolls about twelve or fourteen times. The sheets thus produced are arranged in packets of three in each, heated to redness and rolled, each packet passing through the rolls about ten times. But just before rolling the surface of each packet is cleaned with a wet broom, usually made of the green leaves of the silver-fir, and powdered charcoal is strewn between the sheets.

The sheets obtained from this rolling are sheared to the dimensions of 28 in. by 56 in. Each sheared sheet is brushed all over with a mixture of birch charcoal-powder and water and then dried. The sheets so coated with a thin layer of charcoal-powder are arranged in packets containing from seventy to a hundred sheets each; and each packet is bound up in waste sheets, of which two are placed at the top and two at the bottom. A single packet at a time is reheated, with logs of wood about 7 ft. long placed round it, the object of which is to avoid, as far as possible, the presence of free oxygen in the reheating chamber. The gases and vapours evolved from heated wood contain combustible matter, which would tend to protect the sheets from oxidation, in the event of free oxygen finding its way into the reheating chamber.

The packet is heated slowly during five or six hours, after which it is taken out by means of large tongs, and hammered. The packet is moved so that the blows fall in an order indicated by diagram. After this treatment the surface of the packet presents a wavy appearance, as the striking-face of the hammer and the face of the anvil are both rather narrow. When the packet has travelled about six times under the hammer, in the manner specified, it is removed; and immediately afterwards completely finished sheets are arranged alternately between those of the packet.

The actual cost of manufacturing these Russian sheets is about 12*l.* 15*s.* per ton, to which must be added general charges, which raise the amount to 16*l.* or 17*l.* per ton, exclusive of profit. The average price of sheet-iron at the fair of Nijni-Novgorod is about 22*l.* or 25*l.* per ton.—*Review in the Builder.*

PREVENTION OF RUST.

Dr. Crace Calvert states that iron immersed for a few minutes in a solution of carbonate of potash or soda will not rust for years, though exposed continually in a damp atmosphere. It was believed long ago by soap and alkali merchants that the caustic alkalies (soda and potash) protected iron and steel from rust, but that the components of these salts preserved the same property as they do in a caustic state now. It does not seem to matter whether the solution is made with fresh or sea water.

NEW MILL.

Mr. T. Carr has described to the British Association,—" A new Mill for Disintegrating Wheat." The machine, which is termed a Disintegrator, consists essentially of two discs, each fixed upon a horizontal shaft. These shafts are placed in one line, the discs which they carry at the ends are separated the one from the other by a space of a few inches. Each disc carries a number of bars or studs, disposed in several concentric rings, and standing out at right angles from its face. The concentric rings of studs of the one disc are arranged so as to be in the spaces between the concentric rings of the other disc. The discs are driven in opposite directions, and at high velocity. The rings of studs, although very numerous, do not reach to the centre of the machine; this part is unoccupied by studs, and acts on an " eye " to receive the feed. The first two or three rings of studs beginning at the centre are fixed to one of the discs only, viz., the one opposite to that through which the feed enters, and they serve to distribute that feed equally throughout the machine. So soon, however, as the material has passed by centrifugal force beyond the limit of the outermost of these central or " eye" rings, it is met by the first of the rings moving in the opposite direction. The studs of this ring find the mate-

rial while in mid air, and moving in a direction opposite to their own motion, and with a velocity due to the circumferential speed of the ring of studs which the material has just quitted. The result of this meeting is clearly, first, a violent blow, and then a reversed motion, by which the whole of the material is sent flying through the air in a direction contrary to that which it last had, and with a velocity increased by the increased circumference of the ring of studs which has just put it in motion; a velocity and a direction, however, to be all but instantly arrested and reversed by the action of the next ring of studs; and so the material proceeds from ring to ring until it is delivered completely pulverised at the circumference of the machine. The action will thus be seen to be absolutely different from that of millstones, edge-runners, and crushing-rollers. The proportions of the machines and the size of the studs vary according to the material to be operated upon. For flour manufacture, it is about 7 ft. diameter, and has a space of about 10 inches between the faces of each disc. The studs are circular, half-an-inch in diameter, and are made of crucible steel. The distance from centre to centre of the studs is 2½ inches, and from centre to centre of the rings 2½ inches; so that there is a clear space, both circumferentially and radially, of 2 inches between the studs. The revolving discs are enclosed in a casing, at the bottom of which is the usual worm or screw for carrying away the products. The machine is driven by a counter-shaft, and the ordinary working speed is 400 revolutions per minute. A machine on this principle is now at work at Messrs. Gibson and Walker's, of Bonnington Mills, Leith; and the flour produced is stated to be of a much superior quality to that obtained by ordinary grinding, while the cost of its production is considerably less.

NEW WAR SHIPS.

We have long urged the importance of adding monitors, or low turret-vessels of the American type, to our Navy, both as a second line of defence and to do the heavy fighting in the event of war; and four such vessels are now in course of construction, which may be reckoned as the pioneers of a class of vessel which must soon be widely adopted. The design, however, is imperfect in several particulars. There are two turrets, which are set on top of a breastwork which encloses the two turrets and the chimneys. But such a breastwork increases the target without adding to the stability, and is in every way a most ineligible addition. There should only be one turret in each vessel, which turret should contain two guns of the greatest attainable power, and the turret should be set upon the main deck, instead of being mounted on a breastwork. Monitors, however, now come rather late. The great instruments of destruction will henceforth be submarine guns and submarine rockets or projectile torpedoes. The old plan of torpedoes which are to

be placed under a ship by a long pole will not now do. They must be capable of being shot from a distance, exploding when they come into contact with the bottom of the ship. To carry out this object their mean density must be the same as that of water, so that when fired off they will have no tendency either to sink or swim.—*Mr. Bourne, in the Illustrated London News.*

NEW GUNS.

THERE have been completed, at the proof butts of the Royal Arsenal, the proof of six 25-ton guns, of 11 in. bore, the only guns of that calibre at present in the service. They were manufactured at the Royal Gun Factories, and have been proved with varying charges up to 87½ lb. of powder and 600 lb. shot, the proof cartridge being as usual 1-5th more than the service charge, which for this gun is 60 lb. In appearance they are nearly as large as, and not unlike, the great 35-ton gun (the "Woolwich infant"), which still lies in front of the butts, the principal difference being in the outer coil or jacket, which is much stouter in the case of the heavier gun, and covers more of the inner tube. The bore of the 35-ton gun is 11½ in. in diameter—only ½ in. more than those which are 10 tons less weight, but the additional ½ in permits an increase of the powder charge to 150 lb., and the projectile to 700 lb., and renders the big gun theoretically capable of throwing a shell of that weight about six miles. The 11-inch guns are built upon the Woolwich principle, the system which is now universally adopted at the gun factories for guns of all sizes. Between 30 and 40 10-inch guns, each weighing 18 tons. are lying near the new pier, ready for shipment, some for land service at various stations, and others for mounting on board iron-clad vessels. Ten more of the 35-ton guns are to be manufactured with all speed, and at least one of them has been commenced. They are especially intended for the Navy, and will be probably first used in the three large breast monitors now building. Two of these ships, the *Thunderer* and *Devastation*, are of 4,400 tons burden, and the other, the *Fury*, is of 5,000 tons. Each vessel is to carry four of the 35-ton guns, in two turrets, two guns being placed side by side in each turret.—*Mechanics' Magazine.*

THE RHYSIMETER.

MR. A. E. FLETCHER has exhibited and explained to the British Association his Rhysimeter—a new instrument for indicating the velocity of flowing liquids, and for measuring the speed of ships. The instrument is in principle like the anemometer, recently contrived by Mr. Fletcher, and by which he is able to measure the speed of hot air, flame, and smoke, contaminated with dust or corrosive vapours, as met with in furnace flues and factory chimneys. Both in the anemometer and in the

rhysimeter the impact force of the current, and also its tendency to induce a current parallel with itself, are measured and made to become indicators of the force and velocity of the stream. The apparatus is very simple. A still more important application of the instrument is to measuring the speed of ships. The indicator may be in the captain's cabin. It resembles in size and appearance a barometer. In it a column of mercury indicates continually the speed of the ship. The full effect of the velocity is imparted to the mercury, without any appreciable loss by friction or otherwise, so that the indicators must always be absolutely correct. The instrument may be made self-registering, showing on a dial the total number of knots the ship has run, and marking on a sheet of paper the speed attained at all periods of the voyage. Sir Edward Belcher, Professor Rankine, and others took part in the discussion which followed, and in which great credit was given to the inventor of the instrument.

CANAL PROPULSION.

The Legislature of New York have offered a reward of 100,000 dols. for the best design for Canal Propulsion other than by horse-power which will be applicable to the canals of that State; but the invention is to be practically tested at the expense of the inventor. The boat is to be able to carry, in addition to her fuel and machinery, about 200 tons of cargo, on the Erie Canal, at a rate of speed not less than three miles an hour, and is to be capable of being easily stopped or backed by her engines. The invention is to be applicable to the present canal-boats, and must lessen the cost of transport. The reward offered is a liberal one; but many persons will be deterred from competing by the condition which requires the invention to be tested at the cost of the inventor.—*Illustrated London News.*

FEARFUL EXPLOSION OF GUN-COTTON AT STOWMARKET.

A fatal and disastrous explosion of gun-cotton has taken place at the works of Prentice and Co., Stowmarket, resulting in the loss of nearly 30 lives and a great destruction of property. The men employed at the works, numbering about 130, returned to their employment after dinner at a quarter to two o'clock in the afternoon, and about half an hour later the explosion occurred, creating a scene of death and ruin.

A dense column of smoke rose several hundred yards into the air, and spread into a fan-like shape; then followed a deafening report which shook the walls of every house in the town. This was succeeded by the crash of windows, the clatter of the slates and tiles as they were forced frem the roofs. At once the thoughts of the inhabitants turned to the gun-cotton works, towards which crowds of people were seen rushing. Here the sight was one of desolation, and the wildest fears began to pre-

vail in regard to the safety of the work-people. Nothing appeared to have withstood the shock except the tall chimney shaft. At the moment of the explosion the Messrs. Prentice were absent from the works, but Mr. E. H. Prentice, one of the partners of the chemical works, and his nephew, Mr. W. R. Prentice, son of one of the firm, were quickly on the spot, and every effort was made to limit the area of the catastrophe. Soon the Stowmarket Fire Brigade was in attendance, and commenced to play upon the burning buildings. At this juncture Mr. Edward Prentice, Mr. W. R. Prentice, and other gentlemen hastened to the centre of the works. They saw that the drying and packing sheds were in flames, and began to draw out boxes of cartridges from the sheds. The peril of such action was remarked upon, but Mr. Edward Prentice, relying on experiments alleged to have been recently made by Government officials, replied that there was no danger, and continued to rescue the cartridges by means of a stick, and they were pushed farther from the flames by his nephew, Mr. William Prentice. Suddenly one of the boxes caught fire, causing a second explosion, and both the unfortunate Messrs. Prentice were blown to atoms.

Gun-cotton has been manufactured at Stowmarket for nearly ten years, and when the above explosion occurred the Messrs. Prentice were executing a large order for the British Government; so that they had more than 10 tons of the explosive agent stored up. The gun-cotton works consist of a series of wooden huts spread over about two and a half acres of ground. The most awful exhibition of the force of the explosion was to be found at the spot where the three magazines, in which had been stored over 10 tons of gun-cotton, stood a few hours before. These consisted of three separate buildings 10 ft. by 8, built of wood covered with slate roofs, lined with canvas and calico. Now every vestige of these disappeared, and in their place is an enormous circular pit some 40 yards in circumference, and apparently 10 ft. deep. For a wide space around, the earth is covered with clods of earth dug out and cast up by the explosion, the heaps in the immediate neighbourhood being several feet in height. Close by these stood a row of lofty poplar-trees, of which those nearest the magazines were uprooted, and all were stripped of their branches, many of which were blown long distances away. The explosion originated in the magazines. The drying-sheds were covered with corrugated iron roofs, and some of these lie 100 yards and more from where the sheds stood, whilst bricks and bits of wood were thrown three and four times that distance. Nearer the engine-house were the sheds in which the gun-cotton, having been reduced to pulp, was weighed by girls and women, and pressed into moulds by men. These were not burnt, but were simply levelled to the ground by the explosion, and those who were at work in them were much cut by the glass and slates.

The gun-cotton works were situated on the left-hand side of

the railway running from Ipswich. and the buildings were, with the exception of the old water-mill, which was utilised when the manufacture of gun-cotton was first introduced, all of one storey. Owing to the material being in a wet state when undergoing the various processes, and the precautions taken to isolate the respective buildings, it was thought that a serious explosion was impossible. The works were divided into wet and dry departments; the former included all the processes of manufacture, from the preparation of the cotton, its treatment with sulphuric and nitric acid, its conversion into pulp, and pressure into moulds, so as to form cartridges, and the latter comprised simply drying and storing in three magazines. The magazines were divided by high and solid brick walls with buttresses, and the dry department generally was separated from the rest of the works by an iron frame. The magazines had no windows or skylights, but simply a door to each, and the only work done there was to place the gun-cotton in them as it was taken from the drying and packing sheds, and to withdraw it when despatched from the works. In addition to the manufacture of gun-cotton, the Messrs. Prentice were large maltsters and corn merchants, and they had also established extensive paper and chemical and artificial manure works in the locality. Two years ago a limited liability company was formed to manufacture gun-cotton, with a nominal capital of 45,000*l.* The Messrs. Prentice held nearly the whole of the shares, of which a first issue of 1,570 only had been made, of 10*l.* each, fully paid up. Since the contract to supply gun-cotton to the Government was undertaken, the processes at the works had in a great measure been carried on under the supervision of Government officials.

The destructive effects of the explosion were felt all through the town, and the report was heard at a distance of 20 miles. The appearance of the broken windows in the streets and the injured houses presented the idea of a general bombardment. A farmhouse standing on the same level as the works, and from which it was distant a quarter of a mile, being separated by three meadows therefrom, experienced the full force of the concussion, and was almost destroyed. In some cottages close by, the windows and frames were all blown out, and in one house the first floor has fallen in. But the Gas Works, which stand about a quarter of a mile from the works, and on much the same level. were untouched, while the block of buildings forming the late paper factory and other buildings on that side of the line were damaged.

During the inquest the coroner remarked that there could be no doubt that while striving to render assistance to others, at the most imminent risk, the Messrs. Prentice had lost their lives. At a more advanced stage of the proceedings it was stated in evidence that no cause could be assigned for the explosion, and that the second explosion was caused indirectly by the first.—*Mechanics' Magazine, with four Illustrations.*

TENSION OF FIRED GUNPOWDER.

Captain Noble has read to the Royal Institution a paper on this inquiry.

The practical conclusions to be deduced from the investigations forming the subject of this discourse may be arranged as follows:—

1st.—The maximum pressure of fired ordinary gunpowder, unrelieved by expansion, is not much above 40 tons to the square inch.

2nd.—In large guns. owing to the violent oscillations produced by the ignition of a large mass of powder, the pressure of the gas is liable to be locally exalted, even above its normal tension, in a perfectly closed vessel, and this intensification of pressure endangers the endurance of the gun, while detracting from the useful effect.

3rd.—Where large charges are used, quick-burning powder increases the strain upon the gun without augmenting the velocity of the shot.

4th.—The position of the vent, or firing point, exercises an important influence upon the intensity of wave action; and in further enlarging the dimensions of heavy guns we must look to improved powder, and improved methods of firing the charge, so as to avoid as much as possible throwing the ignited gases into violent oscillation.

5th.—In all cases it is desirable to have the charges as short as possible, and the cartridge so lighted as to reduce the run of the gas to the shortest limit.

SUBMARINE BLASTING.

Some interesting experiments in extensive submarine rock blasting have been made in connexion with the harbour works proposed to be constructed at St. Helier's, Jersey. In order to obtain a sufficient deep-water space at low spring tides it had been determined to remove a mass of syenitic rock below low-water level, and it was with a view to arrive at the best means of effecting this object that the experiments were instituted. Charges of compressed gun-cotton were prepared for these trials by the Patent Gun-cotton Company, of Stowmarket. They were enclosed in water-tight tin cases, each containing from five to ten pounds of the explosive compound. The tins were placed in position under water by a diver, and fired in sets of three at a time by means of an electric battery. The effects of the explosions were very marked; in one instance two tins of gun-cotton of 10 lb. each and one tin of 5 lb. were placed by the diver at the foot of a detached rock, and afterwards fired simultaneously by the battery; the explosion caused great agitation, throwing up a volume of water and stones to a considerable height. It is calculated that about 100 tons of the hard rock were detached and

shaken by this one blast, the entire operation connected with the placing and firing of the charges occupying a little over half an hour. The experiments were instituted by Mr. Coode, C.E.; they showed that, under certain conditions, this powerful explosive agent may be advantageously employed for submarine blasting, and fully bore out all that was stated by Professor Abel as to its valuable properties in his lecture before the British Association.

CHICAGO: THE GREAT FIRE.

THE great fire of Chicago will be recorded in history among the most memorable events of 1871. On Monday, October 9, the startling news reached London by telegraph that Chicago was almost utterly destroyed. General Sheridan, telegraphing to the Secretary of War, at Washington, on the 9th October, said: "The fire last night and to-day has destroyed almost all that was very valuable in this city. There is not a business house, bank, or hotel left. Most of the best part of the city is in ruins. I think not less than 100,000 people are houseless, and those who had the most wealth are now poor. It seems to me to be such a terrible misfortune that it may with propriety be considered a national calamity." The fire began on Sunday evening about eight o'clock, in a stable, from a kerosene lamp being upset among the straw. The flames spread rapidly, and, a strong south wind blowing, by midnight raged beyond control. By three o'clock it reached the heart of the city, and the next day's sun set on three square miles of smoking ruins. The fire exceeded in devastation the great fire of London. These ruins, from the Tower to the Temple, did not cover more than 440 acres. About the same number of houses, 12,000 to 13,000, were destroyed, and as many families made homeless as in the London fire Three-fourths of the city being built of wood, the roofs generally being of asphalted wood, six hundred out of six hundred and sixty miles of sideway being wooden plank-ways, many of the streets paved with wooden blocks—all this rendered the efforts to check the flames hopeless. The blazing fuel was swept by the wind through the air to great distances, overleaping the gaps which the firemen made by gunpowder in the attempt to circumscribe the limit of the conflagration. The loss of property is incalculable, and of lives deplorable. The generous and practical help sent from all parts of America, from England, and other lands, served to relieve the immediate desolation. As to Chicago itself, its prosperity has only received a temporary check. It will rise from its ashes greater than ever.

*Dr. Macaulay, editor of the *Leisure Hour*, visited Chicago last year, and in his work, "Across the Ferry; or, First Impres-

* "Across the Ferry." By James Macaulay, M.D., Edin. Hodder and Stoughton.

sions of America," gives an interesting account of the city in its prosperity.

"Chicago was the place of all others in America I was most curious to see, and which has left the deepest impression. It was certainly to me *the* wonder of the New World. Here is a city scarcely forty years old, with 300,000 inhabitants, enjoying all the advantages of the oldest and most civilised communities. In trade, commerce, and wealth, as well as population, it is already one of the finest cities of the Union. It is the centre of the greatest railway traffic in the world. The average number of trains arriving at and leaving the depôts of the twelve main lines is estimated at 250 daily through the year. In 1850 was laid the first railroad, with forty miles of track; now there are more than forty different railroads having direct connection with the city. Nor is Chicago wonderful only or chiefly for material progress. Its schools equal in number and efficiency those of the oldest States. It has a flourishing university, possessing the most unique library and the most powerful telescope in America. There are five seminaries of different religious denominations, ahead of any similar institutions in the country. There are nearly 200 churches. Sunday-schools and multiform agencies of Christian usefulness assist in the religious training and spiritual oversight of the people of all ages and nationalities. The newspaper press is second to none in the Union for enterprise and ability. Forty years ago the name of Chicago did not appear on the best maps of America.

"The same astonishing progress appears in regard to railway and canal traffic, ships and steamers on the lake, and all matters depending on commercial enterprise and manufacturing industry.

"The vast animal as well as human population of Chicago renders the good drainage of the city the more important. The accomplishment of this is one of the perplexities of the place. The site is low; in fact, the ground was a mere swamp where now stand buildings of solidity and architectural taste, unsurpassed in the older cities of the Union. Still, there is difficulty in securing efficient drainage, and plans are made for artificial currents by canals and steam machinery to aid the natural sewerage towards the lake. The flatness of the site and the nature of the soil enhance our admiration of the engineering skill displayed in rendering the city habitable for so vast a population. The same engineering skill has solved the problem of water supply. The impurity of the lake water near the shore forbade its use as the population increased. A tunnel has accordingly been bored under the stiff blue clay bed of the lake, two miles long, of solid brick masonry, having a clear width of five feet, and height of five feet two inches. A gigantic wooden structure, called the Crib, marks the end of the tunnel, with a lighthouse, serving the double purpose of a guide to the harbour entrance and a protection to the Crib. By powerful pumping engines the

water is raised in a lofty iron column overtopping the highest house in the city. The supply is at present about 20,000,000 gallons daily for about 25,000 houses. The city engineer, E. S. Chesborough, the projector of the Lake Tunnel, deserves honourable mention for the great work.

"The completion of a ship-canal from Lake Michigan to the Mississippi, the tapping of the Indiana coal-fields by opening a line of railway, and the formation of a canal between the lake and the north river to secure constant sanitary current, seem the works most promising for the aggrandisement and convenience of the city. By the residents it is often called the 'Garden City,' apparently on the *lucus a non lucendo* principle, for gardens and parks are as yet in a rudimentary condition. It is more worthy of the titles, also claimed for it, the 'Queen City of the Lakes,' or the 'Queen City of the West.'"

A NEW MITRAILLEUSE.

A NEW Mitrailleuse has been tried at the Camp of San Maurizio at Turin. This new weapon was proposed to the Minister of War, of Italy, by Captain Mussini, of Florence. A Commission of superior officers presided over the experiments. The piece was worked by Capt. Mussini, assisted by the engineer, and the chief of the works where the mitrailleuse was manufactured. The principle is like that of Montigny's system, but with great improvements, which make it a very practical and effective arm; much is due to the great precision attained in the execution of all its parts, carried to a surprising degree of perfection; the deviation of all the parts of the mitrailleuse nowhere exceeds nine one-hundredths of a millimetre, and four one-hundredths of a millimetre in the cartridges. This mitrailleuse has been constructed at the works of Mr. Sigl, of Vienna, the only engineer who has hitherto succeeded in distributing with such precision the openings, so as to fix, without any sensible deviation, the thirty-seven barrels distributed equidistantly in one single circular pile. Each volley lasted two minutes, firing 635 times in each minute, viz., 10 3·5 shots per second.

The experiments were made at the following ranges, each occupying about two hours—viz., at 400, 700, 1,000, 1,500 and 1,600 paces; corresponding to 303·36, 530 88, 834·24, 1,137·60, and 1,213·44 metres. The results of each volley were graphically taken, and were obviously very destructive. The target was formed of a board 2½ centimetres thick, 3 metres high, and 30 wide, normal, and central to the line of firing; at intervals of 25 metres in rear of the first target there were placed others parallel to it, and arranged in such a manner as to represent a battalion formed in columns of companies; so that the shots which passed through or over the first target would strike the second, and so on successively. Of course the number of hits

decreased from the first to the last target when the mitrailleuse was properly trained, but increased when the training was high. The proportion of effective hits is represented in the order of the distances we have given by the following numbers—95½, 79½, 65½, 31½, 27; which shows that even at the least favourable distance of 1,600 paces, 1,213·44 metres, or 1,327 yards, each of the four companies of a battalion formed in column would receive at least one-fourth of the shots—that is, that not one ball is ineffective on columns of companies. Supposing that the 1,600 paces can be run in eight minutes, at the "double;" that the mitrailleuse would fire more than 5,000 shots during that time; and that the battalion is composed of 600 men, each man on the average would have to run the gauntlet of nine projectiles, and that, as we have said, upon the most favourable hypothesis.

The cartridges proved also to be of very excellent manufacture, only two and a half per 1,000, *i.e.*, one in every 400, missed fire. There were no *contretemps* of any kind, and a member of the commission expressed his opinion that humane considerations alone would dictate the rejection of this mitrailleuse on account of its terrible effects.—*Mechanics' Magazine.*

NEW AMBULANCE WAGON.

The old Ambulance Wagon, which foreigners, we believe, somewhat unjustly nicknamed a Noah's Ark, has undergone a great transformation in the new one. The primary requirement in the transport of wounded men is that they should be conveyed with all practical safety and ease from the scene of action to the hospitals in rear. The secondary requirement is that the vehicle should be adapted for the purposes of an insular power like England—such as due strength with lightness of draught, a capability of being easily taken to pieces and put together again, and a fitness for service in different climates and conditions of weather. The wagon is a four-wheeled one, weighs 17 cwt., is drawn by two horses with a pole, and will carry seven patients, two of whom are supposed to be recumbent, besides the driver. It is heavy enough to sustain all that can be required of it, but happily not strong enough to adapt it for general service purposes in the conveyance of stores. The locking arrangement is good, allowing the wagon to be turned in a small circle, and an easily worked break has been adjusted to the two fore-wheels. A hinged wooden framework forms the roof, supported by upright standards of tubular galvanised iron. This is covered with canvas, and the roof has been rendered waterproof by the use of an india-rubber composition for uniting together the double layer of canvas of which this part consists. The hood is movable, and can be thrown back, and the canvas walls can be looped up to any extent for the purposes of ventilation. There are boxes for medical comforts, and adjustments for locking them to the wagon, with a water cistern holding ten gallons, and a box for

forage, fitted to the bottom of the vehicle. The cistern is filled and emptied from below by means of india-rubber tubing with stop-cocks. A funnel-shaped mouthpiece, adjusted to the tube, renders the process of filling easily accomplished. The floor of the wagon is divided longitudinally down its centre for the two recumbent patients, and is furnished with tramways and springed stretcher supports, by means of which, when the back-board is removed, the stretcher that bears a wounded man from the field can be placed upon the wagon and very readily, as well as smoothly, pushed into the position it has to occupy. A tray, at the back of the driver's seat, and above the recumbent patients, is provided for the stowage of the knapsacks, &c. The springed stretcher supports in the wagon have minimised to the utmost any jolting and movement to which a wounded man might be subjected in travelling. Every bolt and other arrangement likely to be lost or mislaid has been adjusted so that it cannot be entirely separated from the wagon. Besides this wheeled vehicle there is another ingenious contrivance for wheeling a wounded man on a stretcher off the field, similar to the stretcher support at Netley, and those used by the Germans. This takes to pieces and packs in a canvas bag. It is easily put together, and the wheels are fixed to the axles by a new and simple method. A man placed on a stretcher, and then put upon the springs of this wheeled support, can be easily pushed along by an attendant. By means of two small contrivances one of the spokes of the wheels on the two sides can be caught and fixed, and the legs of the support being set free behind fall to the ground, enabling the attendant to leave the man with safety if requisite, or to rest for any time. These inventions are certainly pretty and ingenious, but we question whether they will be of much use in the field, although they will doubtless form an excellent and very easy method of removing a disabled man from a ship at a landing-place, or of conveying him along an even road. Although the various details and appliances are simple enough in themselves, there is one point on which we cannot too strongly insist—viz., that if these methods of transport for wounded men are to be properly used the attendants and others in charge of them must be made thoroughly and practically acquainted with their details. Everything seems to us to depend upon the hospital corps being trained and drilled in the use of them.—*Lancet.*

ENGLISH BEET-ROOT SUGAR CULTURE.

The contributions to this new branch of manufacture have been numerous and interesting. Though grown in vast quantities in France and Germany, the beet-root is in England almost entirely used for feeding purposes. There is, however, some signs of English farmers turning the culture to a better account. Mr. James Duncan, of 9 Mincing Lane, and of the Refinery, Clyde Wharf, Victoria Docks, has been successful at Lavenham

this year, and there is no doubt that the beet-sugar industry will soon take root in this country. There is nothing to prevent it. Land is cheaper in England than in France, Holland, or Belgium. We can grow quite as good roots as on the Continent, and, by means of deep steam cultivation, very much better. The cost of growing the roots at Lavenham and delivery to the factory ranges from 9*l.* to 11*l.* per acre, including rent, taxes, manure, labour, and cartage. Part of the manure, however, should be debited to the wheat crop which follows. With fair cultivation, an average crop of fifteen tons per acre is what may be expected. The price paid for the root is 20*s.* per ton, free of earth and leaves. The farmers get the refuse pulp for feeding the cattle at 12*s.* per ton. Three tons of pulp are equal to one ton of hay.—*Chamber of Agriculture Journal.*

Lord Kinnaird writes to the *Times*:—"I see that my friend Mr. Mechi very properly recommends the growth of sugar beet, of course in suitable localities, but at the same time points out the real difficulty of its extended cultivation—viz., the cost of conveyance of roots to the works, and the great expense of erecting these works, which, moreover, is enhanced by their having to stand idle many months, as the supply of roots can only be obtained at one particular season, and within a limited distance from the works. Mr. Mechi recommends underground piping, but an Act of Parliament would be necessary to carry out this scheme, which in itself would be expensive. Mr. Mechi says that the squeezing of the juice is a simple matter, requiring little machinery; if so, farmers could, no doubt, provide themselves with this machinery; but I presume that, as he recommends underground piping, the juice requires to be delivered fresh, otherwise it might be sent to the works in barrels at no great comparative cost of carriage, the farmer getting the use of the pulp. However, if the roots must be taken to the works, the cost of carting them might be materially reduced by the use of Thomson's traction engine or Hodgson's wire-rope tramway, both, I believe, in use abroad. The latter can be erected at no great cost per mile, requires but a small motive power, and can be worked almost for any distance. I have one in use from a stone quarry in the side of a hill, which works admirably. However, though sugar beet is well adapted for those counties where good mangold wurzel can be grown, it is not suited to Scotland or the northern counties."

At the Society of Arts an interesting paper on this subject has been read by Dr. Voelcker, F.R.S. The chairman, Mr. Caird, in summing up the discussion that followed, referred to the growing importance of the subject. The use of sugar in this country has risen from 44 lb. per head of the population in 1869 to 47 lb. in 1870. The imports of 1870 exceeded 700,000 tons, and the consumption 643,000. This is equal to one-eighth in weight of the consumption of wheat, and to more than one-fourth in weight of the annual imports of that grain. Unlike

wheat it may be said at present to be entirely a foreign product. It is important, therefore, to consider the sources of supply of an article becoming to us one of prime necessity. A few years ago Cuba furnished nearly one-half of all the sugar produced; but as slave labour may cease in that island at any moment, and in that case for a time there would be a serious diminution in the crop, and as in most tropical countries the cane crop is dependent on hired Coolie labour, the supply of which is becoming both more costly and more uncertain, the growing increase of beet sugar is a matter not only of great interest, but of great moment. The countries in which it has made most progress are France, Germany, Austria, Russia, Belgium, and Holland. It is in those parts of these countries which most resemble our south-eastern counties in climate that it has best succeeded. The middle and south of France are too hot for it. In the last four years the progress in these countries has been as follows, in tons:—

	1867.	1868.	1869.	1870.
France . .	224,767	213,904	285,146	300,000
Germany . .	165,014	208,140	215,407	250,000
Austria . .	124.068	101,601	152,205	175,000
Russia & Poland	112,500	87,500	132,500	135,000
Belgium . .	31,039	37,078	43,552	50,000
Holland, Sweden, and Italy .	7,500	10,000	12,500	15,000
Totals .	664,888	658,223	841,210	925,000

The first three columns give the ascertained produce; the fourth, that of last year, is the estimated produce the actual produce not yet having been ascertained. Of the total produce of 1870 nearly one-twelfth was imported into the United Kingdom.

We have not space to quote Mr. Caird's details. He sees no reason to doubt that, with great advantage to all parties concerned we may hope by a gradual introduction of sugar-beet growing into the Eastern, the South-Eastern, and South Midland counties, to become profitable growers of a large portion of our consumption of sugar, without any injurious displacement, possibly even with an addition, to our other agricultural produce.

Mr. Sproule, of Dublin, writes to the *Times*:—"Within the past few years a great increase has occurred in the percentage of sugar extracted from the roots, partly owing to improved processes of manufacture, and partly to the production of roots with a high percentage of saccharine matter; and, judging from the progress recently made, there is no reason to suppose that in either of these departments anything approaching the limit of production has been attained. There appears, therefore, to be a future for this manufacture, of which even those now engaged in it can scarcely form a conception.

"The manufacture presents this peculiarity, that, without the requisite local arrangements for the supply of roots, it would be

imprudent to invest capital in buildings; and in addition to the difficulties incidental to the commencement of a new manufacture, it would scarcely be advisable to combine under the same arrangement extensive agricultural operations. In a short time the demand would, as in all other cases, create a supply; and if properly set about there would be no difficulty in making even the preliminary arrangements for the supply of roots from the farmers. This was not the difficulty which led to the failure of the attempt to introduce the manufacture in Ireland."

EXTRACTS OF MEAT.

DR. P. MÜLLER considers that the value of these Extracts in a physiological point of view is much overrated, and quotes in aid of his own researches those of Liebig, Kirchow, &c., in support of his views. He most positively asserts that neither directly nor indirectly should extracts of meat be considered as food, for they neither contain albumenous constituents, nor do they in any way prevent the waste of the organic matter which forms the body; as they contain none of the nitrogenous principles which arrest decay. In small doses, these extracts promote digestion, and increase the circulation by the stimulating effect of the salts of potash they contain; but in strong doses, especially if the system be weakened by long abstinence, as in the case of convalescents from severe illnesses, they may produce very injurious effects. In such cases the system has lost a large quantity of chloride of sodium, and the potassa salts will therefore, instead of performing nutrition, interfere with it, by their direct action on the blood globules, whereby the absorption of oxygen is greatly decreased, and by the predominance of such salts in the serum of the blood, which only dissolve carbonic acid, and do not allow the normal quantity of that gas to be eliminated, thus impeding the access of oxygen, diminishing the circulation, and producing congestion. Medical men are exhorted to bear in mind that, if given alone, these extracts are no nutriment, and tend rather to keep the convalescent weak from want of nourishment, than to increase his strength and promote his digestion.

AUSTRALIAN PRESERVED MEAT.

WE can supply the meat consumers in Great Britain with excellent preserved beef and mutton (says the *Melbourne Argus*) at from 4½*d*. to 6*d*. per lb.; already we manufacture nearly half-a-million pounds a week. Nor is our preserved meat an inferior article, whether in palatableness or nutritiousness. It is only inferior in quality to the best English fresh meat cooked in an unexceptionable manner, and that costs the consumer two or three times as much. To the great body of British workmen and their families, who must either eat second or third class butchers' meat or use animal food only at intervals, our pre-

served meats would prove an inestimable boon, if only they would teach themselves the habit of eating them regularly. They are made from beef and mutton in prime condition; they are so preserved that they will keep good for many years; they are, for the most part, free from bone, and therefore economical in the using. The whole process of manufacture is conducted with the most scrupulous regard for cleanliness, and no meat is permitted to leave our manufacturers' premises until its quality and the sufficiency of its enclosures have been submitted to the most exigent tests. The principal Victorian meat-preserving houses are in the neighbourhood of Melbourne. The meat is preserved by what is known as the chloride-of-calcium process, which expels all the atmospheric air from the tins, and destroys the germs of decay which the meat contains. The various operations are under the management of skilled workmen, and neither care nor expense is spared that would contribute to the final success of the manufacture. The only fault which has been found with the result of all this labour, so far as we have observed, is that the meat is sometimes overcooked; but this blemish is more apparent than real, since the whole nutriment of the meat treated remains in the tins, and something in addition, inasmuch as a quantity of rich gravy is added to each. But there is reason to hope that this slight defect will be overcome before long. Our manufacturers are experimenting with this view, and they have already attained to results which afford reason to expect that by and by their efforts will prove entirely successful.

ENGRAVING ON GLASS.

M. A. Wilbaux finds that words and designs may be printed on glass, by the use of type made of any suitable elastic material. The printing ink contains, however, fluoride of calcium incorporated with it, and when the glass which has been thus printed on is submitted to the action of hot sulphuric acid, sulphate of lime is formed, and hydro-fluoric acid set free, which immediately attacks the glass in the place of its birth. On subsequently washing off the ink stains, &c., the design is found to have been beautifully etched upon the plate.

MATERIAL FOR PAPER.

The British Consul-General at Havannah, Mr. Graham Dunlop, in his Report for the year 1870–71, observes that it is thought that the paper-makers of England should give some attention to the enormous quantities of fibrous tropical plants and trees which abound in Cuba. Successful experiments have been made by local paper-makers on the fibre of the bamboo cane, and on some of the creeping parasite plants indigenous to Cuba. The Consul hears that attention is being given in

Jamaica to the preparation of the fibre of the bamboo for the paper-makers in America. This beautiful plant, or rather tree, grows abundantly in Cuba, and could be purchased and crushed at very cheap rates. It is said to excel, for paper, all the fibrous grasses of late used by our paper makers, and to mix easily with the linen-rag pulp and other more ordinary materials.

PAPER-MAKING IN JAPAN.

An interesting Blue-book has been published, comprising the Reports of our Consuls in the East upon the manufacture of paper in Japan, addressed, through Sir Harry Parkes, to Lord Granville. They will serve to show that, whether or no there is any real ground for fearing that the supply of rags for the paper-makers here may fail, at all events in the far East there are resources which might easily be utilised and imported into the West. Messrs. Lowder, Annesley, and Emslie, each preface their reports by some remarks on what may be termed the antiquarianism of the subject, showing that the manufacture of substances for the purpose of writing in Japan dates from the early part of the seventh century of the Christian era. Consul Lowder devotes his report mainly to an account of the cultivation of the paper-mulberry (*Broussonetia papyrifera*), its planting, cutting, preparation, &c., including the various processes of steaming, stripping, drying, washing, removing the inner fibre, squeezing out the sap, boiling and pounding the fibre, making the "Hanshi," drying, cutting it into sizes, and packing it. He adds a brief account of the treatment of the "tororo," a plant of the bean kind, which is also used for the manufacture of paper. Mr. Annesley gives a similar account of the processes employed in making paper out of the Japanese shrub "kiji," which, as he tells us, grows all over Japan, and is cultivated much in the same manner as the tea plant and mulberry tree. He says that there is no reason why this "kiji" plant should not flourish in England, especially in places where the soil is damp. He adds a formal opinion to the effect that as the paper could no doubt be manufactured from this bark at a cheaper rate than it can be made from rags, and as it possesses considerable strength, and is applicable to an almost infinite variety of purposes, the cultivation of the plant in England is well worthy of a trial. Mr. Emslie devotes his report to a similar account of the planting, cultivation, and manipulation of the makoso or paper-plant, which appears to be equally suited to our manufacturing requirements. It should be added that Consul Lowder's Report is illustrated throughout with most curiously coloured Japanese pictures, descriptive of every process of the manufacture in succession, from the planting of the shrub down to the final process of packing it for export in a prepared state. Each of the three Consuls also subjoins to his report a formidable list of the purposes to which the Japanese apply the paper which they manu-

facture, including not only writing, drawing, and letter paper, paper for walls, for making notes, for wrapping parcels, for Government despatches, &c., but also for pocket handkerchiefs, for umbrella coverings, for hair ornaments, for purses, for pocket-books, for tobacco-pouches, for fans, and finally for rain-coats, like our Macintoshes. It appears from the correspondence prefixed to the volume, that the reports were originally prepared at the suggestion of Lord Clarendon while he was in office, and that various specimens of paper manufacture mentioned by the Consuls in their reports have been sent home to be deposited in the South Kensington Museum.

THE MANUFACTURE OF WOOD PAPER.

COUNT LEWINHAUPE, of Malmo, accompanied by a distinguished Swedish engineer, recently came to England in search of the best machinery for so cutting up the wood of the Swedish forests as to permit of its being used in producing a good paper pulp, from which, without any mixture of esparto grass or rags, good paper, fit either for the printer or the writing-desk may be produced. After going through Lancashire and Yorkshire and the other centres of machine manufacture, they went to Lydney, in Gloucestershire, where, at the works of Mr. James A. Lee, they saw machinery of which Mr. Lee is the inventor and manufacturer which promised to accomplish what they desired. At their request Mr. Lee went with them to Sweden, where, after an interview with numerous landed proprietors who have forests of spruce, and with Prince Oscar, Mr. Lee received orders for several sets of machinery. Since that time orders have arrived from other quarters.

CHINESE VARNISH.

THE *Journal of the Society of Arts* says that among the raw-stuffs sent by Dr. von Scherzer from Pekin, was one called schio-lias, a kind of varnish which is employed for varnishing all kinds of wooden things, and has the property of making these articles water-tight. Dr. von Scherzer has seen wooden chests in Pekin which have been over Siberia to St. Petersburg and back, and still remain sound and water-tight. Even baskets of straw, used for the transport of oil, are, by means of this varnish, made perfectly fit for the purpose. Pasteboard, by its use, becomes, both in appearance and firmness, like wood. Most exposed woodwork is coated with schio-lias, which gives it an ugly, red appearance, but it gains in durability. This varnish was examined by the Australian Agricultural Department, and Dr. von Scherzer's communication was fully corroborated. The "Wiener Gewerbverein" also made trials with it. By mixing together three parts of fresh, beaten, defibrinated blood, four parts of slacked lime and some alum, a thin sticky mass is obtained, which is immediately ready for use. Articles which

are required to be particularly water-tight are varnished twice or at most three times by the Chinese. In Europe this varnish is not yet made, although it is one of the surest and best ways of making wooden articles perfectly water-tight.

THE INSTITUTE OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following premiums for papers read at the meetings during the session:—1, A Telford Medal and a Telford Premium in Books, to Bernhard Samuelson, M.P., M. Inst. C.E., for his "Description of Two Blast Furnaces erected in 1870 at Newport, near Middlesbrough;" 2, a Watt Medal and a Telford Premium in Books, to Jules Gaudard, civil engineer, Lausanne, for his paper on "The Theory and Details of Construction of Metal and Timber Arches;" 3, a Telford Medal and a Telford Premium in Books, to Alexander Beazeley, M. Inst. C.E., for his paper on "Phonic Coast Fog Signals;" 4, a Telford Medal and a Telford Premium in Books, to Thomas Dawson Ridley, Assoc. Inst. C.E., for his "Description of the Cofferdams used in the Execution of No. 2 Contract of the Thames Embankment;" 5, a Telford Medal and a Telford Premium of Books, to James Price, M. Inst. C.E., for his paper on "The Testing of Rails, with a description of a machine for the purpose;" 6, a Telford Premium of Books to Walter Raleigh Browne, Assoc. Inst. C.E, for his paper "On the Strength of Lock Gates," 7, a Telford Premium of Books to Sir Francis Charles Knowles, M.A., F.R.S., for his paper "On the Archimedean Screw Propeller, or Helix, of *maximum* work;" 8, a Telford Premium of Books to Hamilton Ela Towle, of New York, for his "Account of the Basin for the Balance Dock, and of the Marine Railways in connexion therewith at the Austrian naval station of Pola, on the Adriatic;" 9, a Telford Premium of Books to George Banks Rennie, M Inst. C.E., for his "Account of Floating Bricks, especially of those at Cartegena and Ferrol;" 10, a Telford Premium of Books to Arthur Jacob, B.A., Assoc. Inst. C.E., for his paper on "The Disposal of Town Sewage;" 11, the Manby Premium of Books to Wilfred Airy, B.A., Assoc. Inst. C.E., for his paper on "The Archimedean Screw for Raising Water." The Council have likewise awarded the following Prizes to Students of the Institution:—1, a Miller Prize to Frederick Harry Mart, Stud Inst. C.E., for his paper on "Prussian Railways—their construction, cost, and financial results;" 2, a Miller Prize to George Gatton Melhuish, Hardingham. Stud. Inst. C.E., for his paper on "Practical Aeronautics;" 3, a Miller Prize to Arthur Turnour Atchison, Stud. Inst. C.E., for his paper on "The Theory of Energy, and its Application in the form of Heat to the Steam Engine," 4, a Miller Prize to Henry Francis Joel, Stud. Inst. C.E., for his paper on "Bricks and Brickwork;" 5, a Miller Prize to William Tweedie, Stud. Inst. C.E., and a Miller Prize to Francis Wilton, Stud. Inst. C.E., for

their paper on "The Calculation and Designing of Girders;" 6, a Miller Prize to Henry Oliver Smith, Stud. Inst. C.E., for his paper on "Materials employed in Sewer Construction;" 7, a Miller Prize to Killingworth William Hedges, Stud. Inst. C.E., for his "Description of the Pumping Machinery employed at the Works of the Amsterdam Canal."

GOVERNMENT REWARDS TO INVENTORS.

FROM a Parliamentary paper it appears that during the ten years ending the 31st December 1869, the following amounts were expended by the Ordnance Select Committee and the Department of the Director-General of Ordnance in experiments for trial of ordnance and small arms:—Ordnance, &c., 233,327*l.*; small arms, 8,124*l.* These amounts do not include the cost of experiments carried out under the orders of the War Office, by special committees—such as the Whitworth and Armstrong Committee—nor the value of experimental supplies to the troops and to the gunnery ships. The details in the return include the following:—Mr. Snider, Colonel Roden, and Mr. Wilson, 16,000*l.*, for plan of converting muzzle-loading small arms into breech-loaders; Major Palliser for chilled projectiles, 15,000*l.*, and 7,500*l.* for plan of converting cast-iron guns; Captain Moncrieff, for method of mounting guns, 10,000*l.*, in addition to 1,000*l.* a year salary, and 5,000*l.* as a final payment when his services are no longer required; Mr. W. Hale, for rockets, 8,000*l.*; Mr. Frazer, for construction of guns, 5,000*l.*; Mr. Westley-Richards, for breech-loading carbines, 2,375*l.*; representatives of Colonel Baddeley, for patent screw band for rifles, 1,500*l.*; Mr. P. Pettman, for concussion fuzees, 1,200*l.*, in two awards; Mr. Lancaster, for rifling guns, 4,000*l.*; Mr. Clarkson, for compound material for cartridges, 1,000*l.*; Mr. Henry, for prize breech-loading rifle, 600*l.*; with numerous smaller awards to other inventors.

CLOCKS AND CHRONOGRAPHS.

MR. NORMAN LOCKYER has specially devoted a lecture to the methods adopted for dividing and recording time. The ancients divided the day at all times of the year, from sunrise to sunset, into twelve hours of varying length; and the earliest clocks were adapted to this arrangement. Archimedes is said to have constructed a clock with wheels moved by a weight; and the first clock in England is said to have been set up in Old Palace Yard, Westminster, in 1288, by means of a fine paid by the Lord Chief Justice. After referring to other early clocks, Mr. Lockyer stated that they consisted merely of wheels moved by a weight, the means adopted to regulate the motion being successively a fly-wheel, an alternating balance, and an upright arbor, or weighted horizontal bar. An invaluable aid to astronomical science arose from Galileo's discovery, in 1639, of the isochronal

property of oscillating bodies suspended by equal strings; and by Huyghens, in 1656, applying this principle to clocks, thus superseding the balance by the pendulum. Still further progress was made by the ingenuity of Hooke, Clements, Graham, and Harrison. Mr. Lockyer, by the aid of diagrams, explained these successive improvements, and then proceeded to exhibit in action a splendid modern astronomical clock, lent him by Colonel Strange, stating that the principles now demanded in such clocks are that the weight shall be small and the pendulum heavy, and that there shall be as little connexion between the two as possible. He then adverted to the precautions necessary to be observed to preserve the pendulum from the action of temperature as much as possible, and alluded to the advantages of the mercurial pendulum. The way in which the sidereal 24-hour clock is used with the transit instrument was then explained and illustrated, especially in what is termed "the eye and ear method," by means of which the time when a star crosses a line can be ascertained to the tenth of a second. Mr. Lockyer then referred to Sir Charles Wheatstone's patent in 1840 for applying the electro-magnetic force to the record of very minute fractions of time, and then explained the construction of a chronograph, kindly lent to him by Colonel Strange, by means of which the results of astronomical work can be instantaneously recorded by the observer himself with the greatest ease. After noticing various forms of this invaluable apparatus as employed by Airy, Foucault, and others, Mr. Lockyer concluded by demonstrating the great importance of chronographs in the determination of the longitude of distant places, such as Washington.—*Royal Institution Proceedings.*

ANNUAL INTERNATIONAL EXHIBITIONS.

The following is a complete list of the proposed arrangements from the *Society of Arts Journal*:—1872. Cotton, jewellery, musical instruments, acoustical experiments, paper, stationery, printing, machinery for the group, and raw materials for all the above-mentioned objects. 1873. Silk and velvet, steel cutlery and edge tools, surgical instruments and appliances, carriages not connected with rail or tram roads, substances used as food, including agricultural products, drysaltery, grocery, preparations of food, wines, spirits, beer, and other drinks and tobacco, implements for drinking and use of tobacco of all kinds, cooking and its science, machinery for the group, and raw materials for fill the above-mentioned objects 1874. Lace, hand and machine made, civil engineering, architectural and building contrivances and tests, including civil engineering and building construction, sanitary apparatus and constructions, cement and plaster work, &c., leather, including saddlery and harness, leather and manufactures of leather, saddlery, harness, artificial illuminations by all methods, gas and its manufacture, bookbinding of all kinds,

machinery in general for the group, and raw materials used for all the above-mentioned objects. 1875. Woven, spun, felted, and laid fabrics (when shown as specimens of printing or dyeing), horological instruments, brass and copper manufactures, hydraulics and experiments, supply of water, machinery in general for the group, and raw materials used for the above-mentioned objects. 1876. Works in precious metals and their imitations, photographic apparatus and photography, skins, fur, feathers, and hair, agricultural machinery and results, philosophical instruments, and processes depending upon their use, uses of electricity, machinery in general for the group, and raw materials used for all the above-mentioned objects. 1877. Furniture and upholstery, including paper-hangings and papier-mâché, and general decoration, health, manufactures, &c., promoting, with experiments, machinery in general for the group, and raw materials used for all the above-mentioned objects. 1878 Tapestry, embroidery, and needlework, glass, stained glass used in buildings, glass for household purposes, military engineering, army, and accoutrements, ambulances, ordnance and small arms, clothing and accoutrements, tents, camp equipages, and military engineering, arms, ordnance, and ammunition, naval architecture, ships' tackle, ships for purposes of war and commerce, boats, barges, and vessels for commerce, amusement, &c., ships' tackle and rigging, additional clothing for the navy, heating and combustion with experiments, machinery in general for the group, and raw materials used for all the above-mentioned objects. 1879. Matting of all kinds, straw manufactures, flax and hemp, iron and general hardware, iron manufacture, tin, lead, zinc, pewter, and general dressing-cases, travelling cases, &c., horticultural machinery and products, use of magnetism, machinery in general for the group, and raw materials used for all the above-mentioned objects. 1880. Chemical substances and products and experiments, pharmaceutical processes, chemical products, medical and pharmaceutical products and processes, oils, fats, wax, articles of clothing, hats and caps, bonnets and general millinery, hosiery, gloves, and clothing in general, boots and shoes, railway plant, including locomotive engines and carriages, machinery in general for the group, and raw materials used for all the above-mentioned objects.

THE DANGERS OF ANTHRACITE COAL.

THE *Glarner Tagblatt* relates an example of the danger that people incur by burning Steinkohl (anthracite coal) to heat the rooms in which they sleep. In a house near the gasworks two families were residing, a tailor, and a day labourer, with his wife and five children. One morning at seven o'clock, the tailor was struck with the Fact that none of the family of the labourer had yet appeared, the doors of the apartment remaining still closed. This led him to suspect that all

was not right, and, in consequence, he gave information to the police. These officers came and immediately forced open one of the doors, and discovered near the stove a child all but dead from suffocation. When the second door was opened, there lay the mother with her face upon the floor, and grasping with both hands the right leg of her husband, as if craving assistance; the poor man himself, meanwhile, being stretched on the ground unconscious, and utterly incapable alike of saving himself and rendering her aid. It was stated in another paper that the latter died soon after, but, it appears, erroneously; and it is hoped that all recovered, thanks to the medical assistance which was procured without loss of time. No doubt the whole family would have perished but for the well-timed interposition of their fellow-lodger.

THE INFLUENCE OF COLD ON IRON AND STEEL.

It is generally believed by mechanical engineers that frost renders iron and steel brittle. Many civil engineers and a few philosophers who are versed in the theory, though not in the practice of engineering, express contrary opinions, and maintain that iron and steel are just as strong, if not stronger, in the coldest winter than in the hottest summer. It is of some importance thus to classify the adherents to each faith, because we believe that the difference in the nature of the uses to which civil and mechanical engineers put iron and steel goes far to account for the diversity of opinion expressed. It is beyond question that more tires and rails break in winter than in summer, and it is equally certain that in cold weather many vexatious accidents occur to try the temper of the mechanician, which in no way annoy him in summer. We are not aware that these propositions are disputed by anyone; and those who hold that moderate ranges of temperature do not affect the strength of iron and steel, reconcile proved facts with their own theories by calling in some other cause than change of temperature to account for the phenomena the existence of which they dare not dispute. Thus, we are told that tires break in winter because they contract on the wheels, and that rails are fractured because the frozen ballast is no longer elastic; the destruction of castings is explained on the ground that they are cooled too suddenly, and in this way the difficulties with which the believers in the unaltered strength of steel have to contend are evaded, and their opponents are perplexed. It is worth while to consider this question with a view to determine which party is right. The opposing creeds have recently been brought somewhat prominently before the world in connexion with certain fatal railway accidents, the particulars of which must be fresh in the memory of our readers.—*The Engineer.*

COMPOUND ENGINES.

If it can be shown that a Compound Engine weighs less, and takes up smaller space in a ship than a non-compound engine using steam of the same pressure, with the same measure of expansion, and developing the same power, then will a great point be made in favour of the compound principle. But this is just the point which the compound people avoid. When they are pressed they admit that their engines are very heavy, but say they, "Look at the saving in weight of boilers and coal due to the compound principle." This saving in boilers and coal is, however, not due to the compound principle at all, but to the use of large measures of expansion, which might just as well, for any reason so far shown to the contrary, be adopted in engines with single cylinders. Will some one advocating the compound type come forward and give particulars in our pages of the precise weights of the various parts of a good compound and a good non-compound engine, working to the same power, with the same measures of expansion? It will not do for us to produce at this moment the data we possess on the subject. It will be better in every way for the advocates of the compound system to speak first. The objections based on the irregularity of propelling force are infinitely better founded than any others that can be urged against the expansion in a single cylinder system, but they can be got over by using two or three cylinders non-compounding instead of one. However, whatever the force of these objections may be, it is time that the relative merits of compound and non-compound engines should be argued on a basis of Facts between which a true parallel can be drawn.—*The Engineer.*

RESPIRATOR FOR EXTINGUISHING FIRES.

Mr. W. Ladd has read to the British Association a paper "On a Respirator for Use in Extinction of Fires." It combines the advantages of the charcoal and the cotton-wool respirators. The respirator is intended to be fitted on the heads of firemen, and will enable a fireman to enter into the midst of any smoke, however dense. There is a sufficient protection to the eyes, by means of glasses. The results of an experiment with the respirator have been stated by Prof. Tyndall. In a small cellar-like chamber, furnaces containing resinous pine wood were placed, and the wood being lighted, a dense smoke was generated. In this room, Prof. Tyndall, and his assistant, having on the respirator, remained for more than half-an-hour, when the smoke was so dense and pungent that a single inhalation through the undefended mouth would have been perfectly unendurable; and they might have prolonged their stay for hours. The instrument had since been tested by Capt. Shaw, chief officer of the Metropolitan Fire-Brigade, who had taken the greatest interest in perfecting the instrument, attaching to it suitable hoods.—*Athenæum.*

PETROLEUM FURNACE.

M. H. Sainte-Claire Deville and M. Wiesnegg have published, in the *Revue Hebdomadaire de Chimie Scientifique et Industrielle*, a description of an admirable furnace for the combustion of the petroleum oils. It appears to be well suited for laboratory purposes and for manufacture, the heat being very great, and there is an entire absence of ash or smoke.

STUPENDOUS IRON CASTING.

The largest iron casting ever attempted has been successfully achieved at the Elswick Ordnance Works, Newcastle-on-Tyne, under the direction of Sir William Armstrong and Capt. Noble. It is a huge anvil block, weighing 125 tons, to be used with a 20 ton double action forge-hammer, for performing the necessary forging for the 35 ton Armstrong gun.

TRAMWAYS FOR LONDON.

(From the *Builder*, July 1, 1871.)

The promoters of Tramway Bills, until recently, had a good time in the current session of Parliament, many large and important concessions having been granted to Tramway Companies, by the House of Commons especially. Amongst these are the Paddington, St. John's Wood, and Holborn street lines, of seven miles; the West London, of seven miles; the London street (Kensington, &c.), nine miles; London Street Extensions, three other bills, twenty-three miles; with bills of the Metropolitan, the North Metropolitan, the Pimlico, Peckham, and Greenwich, and other companies, to whom powers have been given by the Commons to construct nearly 130 miles of tramway in London and its suburbs. In addition to these lines there are about twelve miles of tramways already open, and more than thirty miles to add to these that are authorised and partly constructed. When all the schemes already authorised have been carried into effect, users of the tramway cars, as well as users otherwise of the streets of London, will have very full means of judging of the value of the tramway system, and of its compatibility with other kinds of street traffic. Although so many important bills have passed the Commons, everything is not quite *couleur de rose* with the promoters,—there are flies in the ointment. It may not be much of a blow or discouragement that the Metropolitan Street Company are not to be permitted to take up or let down passengers on Westminster Bridge, or that they must turn round to the Embankment short of the Clock Tower, and be debarred from passing New Palace Yard, or crossing the approaches to the House. It is true that it detracts from the prospects of traffic that there must be a break in the tramway communication between the Sanctuary and Bridge Street, Westminster, and that the cars must not emerge from the end of Whitehall Place into the thoroughfare opposite the Admiralty.

These, however, are not the chief causes of disquietude, but rather the disposition on the part of the Legislature to subject the tramway companies to the liability of having their powers and privileges cut off summarily, by the lifting of the tramways on certain representations and findings. Mr. Dent's committee passed the London Street Tramway (Extension, &c.) Bill, which includes, among many sections, one of above six miles in length, from Shepherd's Bush, by Uxbridge Road, Oxford Street, and Holborn, to Newgate Street. The committee, however, seemed to have a misgiving in sanctioning this project, and proposed a clause to the effect that the tramway should be removed at once if adequately proved to be a nuisance. On the remonstrance of the promoters, we believe, the clause was withdrawn, on the understanding that they would give a clause in the Lords. The Metropolitan Street Company got their Westminster, &c., Bill in the Commons loaded with the condition that the First Commissioner of Works may order the removal of the tramway on the expiration of forty days after notice of removal has been laid on the table of the House.

The impression is rightly gaining ground that Parliament is going too fast and too far in sanctioning tramways so freely and extensively as the Houses are doing. There can be little doubt that a reaction will set in, not against the tramways, but against the manner in which they are introduced, held, and conducted. The principles recommended by the vestry of St. George, Hanover Square, are certain to grow in public favour, namely, that concerning tramways the following things are desirable:—1, their construction upon one broad, uniform, and comprehensive design, adapted to the wants of the whole metropolis; 2, their correspondence in working; 3, the control of the streets and street traffic in the hands of the public authorities; 4, the whole pecuniary profit to the ratepayers. The tramways are in great favour at present; the reaction will come when the streets have to be taken up, in two or three years, for the renewal of the wooden sleepers, which are of very poor quality, and not creosoted or otherwise treated for preservation, upon which the rails are laid. A weak point in the tramways, as hitherto constructed, is that they are much farther removed than even the railways from being worthy of the designation "permanent way." In a few years there will be a necessity for constant repairs, that will greatly imperil the success of the tramway system, and this point, above all others, demands the attention of tramway promoters if they desire to escape an outcry in the future, in which users of the public thoroughfares, "frontagers," and the local authorities will be of one accord.—*The Builder.*

ROAD STEAMERS.

Notwithstanding the stupid restrictions on the running of steam carriages on roads, such as walking with a red flag in

front of them, they are making progress. The severe frosts have put these steamers, which have lately begun to rise in public opinion, to a severe test. Happily, it is said, they have gone through it successfully. Mr. White, of Ketock's Mill, near Aberdeen, worked his road steamer regularly throughout the frost. It runs between the mills and the town, a distance of three miles, part of which has a rising gradient of 1 in 10. Up this steep incline the road steamer bravely drew a load of seven tons, though the road was covered with solid ice. The wheels of these steamers are covered with india-rubber tires, and as india-rubber does not slip on ice, the steel guards are removed, and the engines do not slip. The question is a very important one as regards the practical value of the steamers, as they can now be used for regular traffic in very cold countries, such as Russia and Canada, where sledging is commonly employed. The india-rubber tires run over almost any kind of surface, and can consequently, it is believed, be used on the dry hot sands of India as well as on frozen roads.

Thompson's road-steamers are about to be brought into use in India. It is intended to run them between two stations in the Punjaub, viz., Rawul Pinde and Jhelum, 68½ miles apart. The boiler is on the vertical principle, by which means a nearly uniform water level is maintained when either ascents or descents are being made, a thing in itself of great importance. The india-rubber tires are about 4½ in. thick, and flatten with the weight of the engine, thus giving great adhesion and elasticity on bad roads. The engine runs on three wheels only, and in this way a small wheel base is obtained and great facility given for steerage. This train will on ordinary occasions consist of one, and on extraordinary occasions of two omnibuses, and will run the distance in seven hours, inclusive of all stoppages. One omnibus will carry 20 first, 20 second, and 20 third-class passengers, with 50 cwt. of mails and luggage, which will be sufficient for every-day traffic. The steamers are well-known in the streets of Edinburgh.—*The Builder*.

IS ST. PAUL'S CATHEDRAL SAFE FROM LIGHTNING?

As St. Paul's is now undergoing extensive renovations, it may be well to call to mind the Fact that the Cathedral Church of St. Paul has been three times burnt by fire and twice struck and burnt by lightning. Besides these more fatal events, other narrow escapes from similar accidents are on record; and it may therefore be worth the while of those in authority to ascertain whether, in the various alterations which occasionally occur in such buildings, anything has been unwittingly done to destroy the perfect action of the apparatus invented for protecting this noble fabric from the effects of lightning. In 1870 the church most celebrated in London for its specimens of early English

architecture was, for the second time in a quarter of a century, struck and greatly injured by lightning; and this occurred from sheer ignorance of the principles by which such buildings may be effectually protected. Scarcely a year ever passes in which some (and sometimes several) of our churches are not greatly injured by this cause, which a very small amount of forethought might prevent.

About 100 years ago, St. Paul's Cathedral had another very narrow escape from being struck by lightning, the steeple of St. Bride's Church having saved it on that occasion. A committee of the Royal Society was thereupon requested to advise on a plan for protecting the Cathedral from lightning. On examination it was found that, with every facility of easy protection, the structure was in a most dangerous condition. There was a vast amount of attracting material for the lightning, while from want of continuity in the various metallic conductors the only surprise was that it could possibly have escaped so long the threatened destruction.

The plan proposed for protection was simple and efficacious, but time alters all things; and as oxidation of metallic substances is supposed to destroy the power of conducting electric currents, it may possibly be well to ascertain whether this result, added to the possible ignorance of workmen in making alterations and repairs during a period of a century, has really left the ingenious adaptations proposed in 1770 in efficient working order at the present day.

The apparatus for protecting St. Paul's from lightning was totally different from any other lightning conductors. It consisted of a most ingenious mode of combining the various metallic portions of the building so as to secure perfect continuity from the summit to the base. When examined in 1769 it was found that numerous breaks occurred between the various metallic portions, some being 40 feet and some 80 feet asunder. The plan then proposed was to unite all these into one continuous arrangement, and thus secure a passage for the electric fluid from any part that might be struck by lightning, and convey it into the earth.

The cross and ball, which are both composed of metal, are connected by seven rods of iron. These descend through the leaden dome which covers the lantern, and pass through a strong timber frame. From this timber frame several large bars of iron pass obliquely into the stone-work of the lantern. Here occurred the first break of the continuity. This was remedied by four iron bars, one inch square, being placed in contact with the four iron rods, and carried down to the second set of rods already mentioned. Here a very large iron ring was placed in contact with all these bars; and from this ring four more iron bars are carried down to connect all the parts previously mentioned with the lead covering the great cupola, which is 48 feet distant. From this large metallic surface of lead covering the

great cupola the metallic water pipes are made to act as conductors, which discharge on to the floor of the stone gallery.

From these pipes there was another break in the connexion, which was remedied by adding large connecting pieces of lead, which unite the upper range of water pipes with those which descend still lower, and discharge upon the outside or drum part of the great cupola and deliver their water upon the roof of the church. Here another break occurred, which was remedied in the same manner by leaden connexions. From the roof last described the leaden pipes are continued perpendicularly to the ground, and enter the earth for three feet below the surface. By these various connexions a continuous communication is made from the highest point of the cross to the ground.

The two towers at the west side of St. Paul's were found to be wholly unprotected. The north tower, with the pineapple on its summit, which is made of copper, was found to be 88 ft. distant from the nearest metallic substance—namely, the lead covering the roof of the church. These were connected together by a bar of iron 1¼ in. square, and from the roof of the church the communication with the ground was already completed by the arrangements made for the great dome.

The other, or south tower, contains the great bell. Here there is an iron staircase inside, of great height, made to get at the clockwork. This staircase was connected at the upper end with the pineapple on the clock tower by a bar of iron 1¼ in. square, and from the bottom by a similar bar for a length of about 40 ft. reaching on to the roof of the church, and thence to the ground as previously described.

These complicated connexions to secure this noble building from the destructive effects of lightning have been sufficient for many years. It is certain, however, that many of them would now be differently applied if the work were to be done at the present day. But without entering into the precise form which modern science would propose, it is asked whether it is certain that the various alterations and renovations which have been made during the last hundred years have really left all these various conecting links intact, and as effective as they originally were; and is it at all certain that the "improvements" which have been made from time to time may not have removed some of these connecting links, seeing that several of them only consist of leaden bands, easily bent or separated, and of which the exact use would not be very obvious to persons ignorant of the precise object they were intended to answer? It is doubtful whether such leaden connexions would now be used, as the copper protectors invented by Mr. Snow Harris many years ago afford a mode of connexion much safer and more perfect.—*Letter to the Times.*

GREAT BALLOON JOURNEY.

An interesting scientific communication has been placed before the French Academy. It is an account of a balloon journey undertaken on December 2, 1870, for the purpose of observing the expected total solar eclipse visible at Oran, in Algeria. M. Jansenn, who communicates the paper, was himself the aeronaut, but the expedition was sent out by the Parisian Government. The huge balloon, "The Volta," was filled with illuminating gas, which gave it an ascensional power of 1,400 kilogrammes. The balance of this was made up by the following items:—The weight of the car with its network gear, 520 kilos.; the weight of the two passengers, M. Jansenn and a sailor who accompanied him, 150 kilos.; for the necessary astronomical instruments, 160 kilos.; and the remaining 570 kilos. ballast. The Volta ascended at six A.M., and reached the village of Briche-Blanc at half-past eleven, having travelled a distance of 250 miles at the incredible rate of 50 miles an hour. At its first ascent it rose so slowly as to be scarcely out of the range of the Prussian bullets, from which it was protected rather by the darkness than by the distance; but when it had passed so as to be above the river Eure, M. Jansenn saw the splendid sight of the rising sun, and then he remarked, as one of the strangest phenomena of the whole excursion, that the thermometer fell to eight degrees centigrade below freezing point. M. Jansenn explains this by showing that the solar rays had first to disperse the vapours in the air, and that the radiation of heat from the balloon towards the sky necessarily increasing produced the fall in the temperature. This experience would support the theory so strongly entertained by some modern men of science, that the moon has the power of dissipating vapour and light clouds, and we know that the Hindoos actually pray for the intervention of the stars in the production of ice in Bengal during the night. Upon one practical point, M. Jansenn gives very excellent advice: he suggests that the use of the anchor should be entirely discarded. It is his experience that this instrument either breaks, in which case it is worse than useless, or, if it resists, it occasions such a shock to the balloon as to be more dangerous than contact with an obstacle. M. Jansenn has substituted for it a guide-rope, which stops the balloon gradually by its friction on the ground. This apparatus needs only to be provided with bits of iron stuck in at intervals, which will catch up in its course objects which may stay its progress.—*The Globe.*

ARE MEN TO FLY?

The symbolical present sent of old by the Scythians to Darius, son of Hystaspes, was interpreted to signify that unless his men could swim through the water like the fish, or burrow through the ground like the mole, or fly through the air like the bird, they should perish by the Scythian arrows. Two of the ex-

pedients deemed impracticable by the Scythians have been rendered possible by the skill of modern mechanicians and engineers. Men can now urge their way through the waves of ocean without waiting for favourable winds; they have long since learned to tunnel through hills, and have now achieved the task of piercing their way through the mighty Alps; is the time approaching when the third of the paths indicated to Darius by the Scythians will be traversed by daring men? We speak of something more, of course, than of mere aerial voyaging by means of balloons, for the balloonist does not pursue his own course, but is simply carried along by the air; the wind bloweth (him) where it listeth, and not where, if he had the power, he might prefer to travel. The great problem which the aerial voyager has to solve, is to learn how to direct his path through the air as the captain of a steamship selects the course on which he will proceed, or as the birds direct their path when migrating on the approach of winter. Are we to suppose that men will presently be able to accomplish this feat? It would seem at least that scientific men consider the feat to be possible; for an aeronautical society has now been for several years in existence, and in its ranks are many well-known men of science, while its president, Mr. Glaisher, is well known not only as a man of science, but as an aeronaut of some experience. It is also worthy of notice that mechanicians no longer despair (as lately) of mastering the serious mechanical difficulties involved in the problem. They not only believe flight to be possible, but give sufficient evidence in support of their opinion.—*The Spectator.*

COPPER BALLOONS.

JOHN WISE, of Pennsylvania, the aeronaut, recalls his suggestions for the use of Balloons for the capture of the fortress at Vera Cruz, during the war with Mexico, in 1843. He proposed to elevate balloons above and near the fortress, to a height of from one to five miles, with cable attached, and then to hurl down explosive shells in such numbers as to render the fortificasion untenable. Mr. Wise thus describes a copper balloon of his own invention. One of 200 feet in diameter could be constructed of copper weighing one pound to the square foot, which, deducted from its ascensive power when inflated with hydrogen, would leave 68 tons of lifting power. Such a machine, constructed inside a framework from which to solder it together, could be easily inflated, by the expansion of a cloth balloon inside of it filled with atmospheric air, and then the hydrogen was introduced between the inside copper surface and the bag of atmosphere, so that, as it filled with gas, the atmosphere and its envelope would be expelled from its lower orifice. To meet the necessity of the expansion and contraction of gas in the copper war-ship, it would have to be supplied with an India-rubber diaphragm in its lowermost section, which would rise and fall agreeably to the necessity as it occurred.—*Scientific American.*

AUTOMATIC WEIGHING AND CLASSIFYING MACHINE.

ONE of the leading mechanical attractions at the Conversazione of the Institution of Civil Engineers was an Automatic Weighing and Classifying Machine for coins and counter-blanks. This was exhibited by Mr. J. M. Napier, and is one of a number about to be sent to a foreign mint. The apparatus has a hydraulic motor, and stands upon its own base, and independently of the building floor, in order to prevent the inaccuracy arising from vibration, is enclosed within a case having glass sides and a metal top. The coins to be weighed are passed down a trough through an opening in the cover upon the weighing table, and by a most delicately adjusted balance, the weighing table remains stationary, rises or falls, as the coin is just, light, or heavy; if the former, the feed movement which pusher the coins forward one by one to be weighed advances with a second coin, the first is thrown off, and passes down a hopper into one of three openings leading into its proper drawer below. If the piece is too light, the slight difference of balance shifts the hopper over another opening, and if too heavy over a third, the coin being always pushed off and sent into its proper receptacle. In this way and by this apparatus the coins or blanks are weighed and sorted at the rate of 30 a minute. This speed is the highest practicable, as any increase is found to disturb the perfect accuracy of the machine.—*Mechanics' Magazine.*

BALLOTING APPARATUS.

AT the late Conversazione of the Institution of Civil Engineers was exhibited a very ingenious Balloting Apparatus by Messrs. Haddan and Imray, which was manufactured by Messrs. Saxby and Farmer, of the Canterbury Road, Kilburn. In this apparatus the voter enters a chamber, on the wall of which the names of the candidates are written. Under each name there is a handle which projects from the wall. The pulling down of any handle registers a vote for the candidate whose name is over the handle. The apparatus can be set so as to enable the voter to give one, two, or more votes, according to the number of candidates to be elected. The voter can only pull one handle at a time, and having pulled down the permitted number cannot pull down more. When the first voter has left the chamber, the official in charge pulls a latch to open the door for the admission of the next. This releases the handles that had been pulled down. Thus, the second voter has no knowledge of the votes given by the previous voter, but finds all the handles ready to be acted upon as he may elect. The votes are recorded by mechanical counters, one to each candidate. These counters are concealed while votes are given, so that the voting is kept absolutely secret. At any desired intervals they can be inspected to order to ascertain the state of the poll.

ASPHALTE PAVEMENT.

In the *Year-Book of Facts*, 1870, we described the experimental carriage-ways of Asphalte in the Poultry and Cheapside. Lombard Street has since been laid, as an experiment, with Limmer asphalte, a substance deriving its name from mines which produce it, situate at Limmer, near the town of Hanover. It has been many years in use in several of the large cities and towns on the Continent, but practically is comparatively little known in this country. At the International Exhibition of 1851 it obtained the prize and was awarded a gold medal; again, at that of 1862, a prize and a gold medal; and a prize and medal at the Industrial Exhibition at Hanover in 1859. It has been the subject of what may be called a crucial test on part of Bermondsey Street, Borough, which is daily traversed by traffic of the heaviest kind. The trial to which it is to be put in Lombard Street is being made with the express permission of the Commissioners of Sewers, who are charged, as is generally known, with the maintenance of the streets of the city and their control in several respects. The thoroughfare there covers about 1,700 square yards, and the contractors have engaged to pave 500 yards of it with that particular kind of asphalte gratuitously, and to keep it in repair for two years, as a consideration for the permission to test its qualities. It is laid down in a boiling liquid state in two separate layers, each about an inch thick, and rests upon a bed of Portland cement concrete nine inches thick. When complete it presents a level surface to the eye, and is said to be comparatively noiseless from carriage traffic, and sufficiently rough on the surface to lessen, if not wholly prevent, the danger of horses falling upon it. It is also said to be free from a tendency in some other kinds of asphalte to become "wavy" on the surface, and so to collect the rain in little pools. For years Lombard Street, as the great centre of the banking quarter in the City, has been paved with wood, but the thoroughfare has lapsed into ruts in many places and fallen into disrepair in others, and the Commissioners have taken advantage of the opportunity of testing the new substance. Latterly, they have subjected the Val de Travers compressed asphalte to a trial in Threadneedle Street, Old and New Broad Streets, and, upon a larger scale, in Cheapside and the Poultry, with satisfactory results upon the whole, and their engineer, Mr. Haywood, has reported favourably with respect to it. With the same desire to promote the public convenience, they are now affording facilities for testing the rival asphalte.

THE BRIDGES OF LONDON.

Mr. Henry Carr has read to the Royal Institute of British Architects a paper on "The Bridges of London." The points of view from which Mr. Carr considered the subject were—historically, as connected with the varying circumstances of the

metropolis in early and later times; simply as a means of communication considered with reference to the localities on each side of the river, and to the traffic as developed by increased population and trade; as mechanical structures, solely with reference to strength, stability, and efficiency for the duty required; and as architectural works in the more common acceptation of the term—namely, as works of art. In dealing with the first point, he said it seemed clear that during the Saxon reigns a timber bridge was carried across the Thames about the site of the present London Bridge. This timber bridge was many times wholly or partially destroyed, the Danes at times being the destroyers; but it was as constantly renewed until the original stone one was built, and this, commenced in 1176, was not completed until 1209, the funds for its erection being collected by one Peter of Colechurch, who preached on the national necessity of a stone bridge. The after maintenance of the bridge was for many generations regarded as a pious work, and the bridge was classed with hospitals in exemptions.

Mr. Carr then proceeded to give many interesting details connected with the history of the bridge, and he stated that the Corporation had to repair it on the order of King John in 1213, but in 1249 Henry III., who then quarrelled with the City, took the income into his own hands. In 1252 the bridge was, however, found to be under the Corporation, and at an early period the "Bridge House" was used to store corn during times of famine, and ovens were then erected for baking for the poor. In 1594 a demand by Admiral Hawkins for corn and the use of the ovens for the fleet was successfully resisted by the Corporation. In the years 1465–1482 and 1506 the expenditure on the bridge and the rentals seem to have been from 650*l.* to 815*l.* In the years 1533 to 1664 the rental ran up from 840*l.* to 2,054*l.*, and from 1727 to 1753 the rentals were from 3,299*l.* to 3,843*l.* In 1685 the first widening was made, increasing the width from 12 to 20 feet. The question of a bridge at Westminster was mooted in the reign of Charles II., but the project was opposed by the Corporation as likely to injure the interests of the City to a most alarming extent. In fact, it was urged that "London would be destroyed if carts were allowed to cross the Thames elsewhere" (than over London Bridge). "The rich City prevailed with the money-spending Monarch, and the bridge of Westminster was postponed for three generations." In 1750 Westminster Bridge was thrown open, and ten years afterwards the houses on London Bridge were entirely removed, and the bridge was widened in the roadway to 43 feet. Nine years afterwards—namely, in 1769, old Blackfriars Bridge, pulled down a few years ago, was opened, and was 45 feet wide; Waterloo Bridge, 42 feet wide, was opened in 1817; Southwark, the same width, was opened in 1819; new London Bridge, with an increased width of 11 feet over the old, was opened in 1831; new Westminster Bridge, with an increase of 42 feet in width

over the old, was opened in 1862; and new Blackfriars, with an increased width of 30 feet over the old, was opened in 1869. This formed the history of the bridges between London and Westminster.

On the second point, that of "the bridges considered as a means of communication," Mr. Carr held that bridge communication between the two sides of the river was needed in the neighbourhood of the Tower, and he maintained that the widening of London Bridge would not remedy the want, as the approaches to the bridge were not sufficient to meet an increase in the bridge itself. The utmost which could be attempted was a proposal to add 27 per cent. to the footpath, and the advantage of this, he said, would be evident to anyone who watched the traffic at certain periods of the day. The carrying out of this suggestion—the pushing out of the parapets over the cornices—would not interfere with the general elevation of the bridge as seen from the river. He urged that the great object should be to divert the traffic westward over Southwark Bridge, and he pointed out that the steep approaches to the bridge and its narrow width must be remedied before it would become of general use.

Mentioning the other bridges, he said it was desirable Waterloo Bridge should be thrown open toll-free, though this was not to be expected under the circumstances that the bridge pays annuitants a good sum, but the original shareholders nothing. Lambeth Bridge, he then went on to say, was built to meet a supposed want, but it was singular how little traffic really went over it, and the toll was the great cause of this limited traffic. Vauxhall Bridge had suffered a loss by the formation of the Southern Thames Embankment, and Chelsea Suspension Bridge was one which he held would become of still greater importance in time to come, when the southern side was more populated.

The reader then entered on a lengthy description of the bridges as mechanical structures, with reference to strength and stability, and the technical points relating to the foundations, not only of these bridges, but of the railway bridges—the Charing Cross (South-Eastern), the London, Chatham, and Dover (at Blackfriars), and Cannon Street (South-Eastern)—were given in detail. Considering the bridges as works of art, he acknowledged the difficulty the builders had had in having to throw the London bridges from the high ground on the City side to the low ground on the Surrey side, and he dealt with the materials used in bridge-building, discussing the various qualities of stone, stone and brick, and iron.—*From the Times.*

FLOATING BREAKWATERS.

Mr. Cargill, A.B., has read before the Society of Engineers a paper on these proposed Breakwaters. One of the most important points in connexion with Floating Breakwaters is that the

theory of the action of the waves be thoroughly understood. The author, therefore, devoted a portion of the paper to this subject, and described the origin of waves, their division into two principal kinds—namely, waves of oscillation and waves of translation. The effect they produce upon obstacles and structures in the sea; the conversion of a wave of oscillation into one of translation, and consequently the formation of breakers, were points also treated of. A question which has for a long time engaged the attention of those having marine engineering works in hand is the depth to which the influence of the waves extends. Upon this depends the whole theory of floating breakwaters. Taking an average of opinions, Mr. Cargill assumes that at the depth of 15 feet below the surface the influence of waves practically ceases, and that we then have what he terms the zero line, a place of no motion. It may be added that actual experiment has confirmed this hypothesis. There can be no doubt as to the truth of the objections urged against solid breakwaters. In the first place, there is their enormous cost; secondly, it is practically impossible to construct them in some localities where they are urgently required; and, thirdly, when they are built they cause the deposition of silt to such an extent as in many instances to render them in a few years completely useless. The cost of existing examples of solid breakwaters is stated by the author to range from 150*l*. to 415*l*. per foot run. It appears, also, that it requires an annual expenditure of 15,000*l*. to keep Plymouth Breakwater in repair. The first idea of floating breakwaters was probably taken from an observation of the effect produced upon waves by the presence of some natural obstacle in the sea, such as reeds and seaweed. The Gulf-weed is a well-known instance. It has been found that, although its depth does not exceed a couple of feet, yet, even in strong gales, there is perfectly calm water to leeward of it.

Having described the different kinds of so-called floating breakwaters which have appeared at various times, Mr. Cargill arrives at the conclusion that they are all crude and imperfect, as was, in fact, shown by their failure. He considers that, in a permanent structure designed to fill so important a duty, timber must be rejected, and wrought iron employed. He also states that floating breakwaters designed on the single screen principle, or with only one row of cylinders, however true in theory, will not answer in practice. The type of floating breakwater Mr. Cargill proposes, as calculated to fulfil all the conditions demanded of it, is one which is composed of a number of sections about 100 ft. in length. Each section is in the shape of a triangular wedge, with the apex towards the sea. The wedge is right-angled, and has one horizontal and one sloping surface. The horizontal surface is nearly level with the water, while the sloping side extends from the apex to the bottom of the perpendicular to the depth at which the plane of no motion is situated. In the breadth of the breakwater, which is com-

posed wholly of wrought-iron lattice framework, is a series of vertical or inclined plates with intervals between them, increasing in depth from the sea face to landward. The theory of the action of the breakwater is that, in passing through these screens as well as through the lattice work, the waves would be gradually and successively disintegrated and strained, as it were, of all their violence, until they reached the landward side of the barrier in a state of complete quiescence. The cost of these structures is put at about a tenth of that of the average cost of the solid structures. In the discussion which followed the reading of the paper, the principle of the floating breakwater proposed was pronounced correct, but the question of mooring it was raised. The opinion however, of naval men present was that there would be no difficulty whatever upon the point, inasmuch as the floating breakwater was aptly represented by a sieve, and was not at all analogous to a solid body such as a ship, which offered great resistance to the water, and consequently brought a considerable strain upon her cables when anchored.

A CHANNEL TUNNEL.

Mr. George Remington has addressed to the *Times* the following letter upon this subject:—

The completion of the Mont Cenis tunnel, which may be looked upon as the greatest engineering triumph of the age, not even excepting the Suez Canal, the advantages of which are only now beginning to be realized, ought to be sufficient to stimulate this country and France to increased exertions to carry out that still more important engineering work, the tunnel under the Channel.

That such a work is not only practicable but easy, I have from time to time during the past few years endeavoured to show, but the line must be laid to avoid the chalk and follow the Wealden, which contains thick beds of clay, extending between Dungeness and Cape Grisnez; and therefore there would be no possibility of meeting with sea water at the depth of 100 ft. below the bed of the Channel, at which level the tunnel would be constructed, because this formation is not, like the chalk, porous and full of fissures, but being a diluvial fresh-water deposit, the greater part of it is as impervious as the London clay, and the tunnel can be constructed with as much ease and certainty as was experienced in the construction of the tunnel sewer under Oxford Street.

On comparing the Dungeness and Cape Grisnez line with the line which has been proposed between Dover and Calais, the promoters of which state that they require the Governments of England and France to unite in giving a guarantee of 2,000,000*l*. for the purpose of constructing two trial driftways through the chalk, it must be borne in mind that both the upper and lower chalk crop out in the Channel, and in the deepest parts of it are quite bare of any plastic covering to resist the great head of water to be encountered. These driftways, therefore, can only be

looked upon as experiments, and, if successfully carried out, which, for the reasons above stated, seems impossible, the further sum of at least 8,000,000*l.* is required for the tunnel; whereas I contend that a tunnel for a single line of railway can be carried out between Dungeness and Cape Grisnez in less than half the time and at less expense than the sum required for the two driftways, and when completed it would be available for traffic, and therefore the more speedily remunerative.

A single line tunnel once constructed, with bays or recesses at intervals, on one or both sides, a second tunnel can be carried out even in less time than the first, as described long ago in my communications to the Board of Trade, and in this way the requirements extended according to the amount of traffic to be accommodated, but all that would be required from the two Governments would be the guarantee on the cost of constructing the first tunnel, and I am convinced that it would be better disposed if applied to the construction of a line between Dungeness and Cape Grisnez than in experimenting on the driftways through the chalk.

On further comparing the two projects, it appears that the length of the Dover and Calais tunnel under land and sea will be 29½ miles, and the Dungeness and Cape Grisnez line 28 miles, assuming both to be at equal depths, and to have equal gradients from the approaches; that on the latter line there is an extensive shoal covered only by a few feet of water at low tides, and there it would be easy to construct a shaft, by which means the works of tunnelling would not only be effected more rapidly, but the shaft would serve as a more perfect means of ventilation.

There are many other advantages in favour of the Dungeness and Cape Grisnez line. It would be more central as regards the existing railways; more in the direct line between London and Paris. The spoil from the excavations could be advantageously disposed of in reclaiming and bringing into use an extensive tract of land now of but little value, and there are plenty of materials at hand which may be made use of in constructing the works.

In conclusion, I may remark that in all river and sea works, when it is desired to keep out the tidal water during the time of construction, and in the bottoms of docks and canals, clay is the material best adapted for the purpose; and I believe that the majority of engineers and contractors will agree with me that to insure success in tunnelling under water, clay is the best, if not the only material that can be relied on.

NEW BUILDINGS AT SOUTH KENSINGTON.

The general scheme for the South Kensington Museum has been sanctioned, and is to cost, we believe, some 400,000*l.*, towards which Parliament has hitherto voted grants of about 25,000*l.* a-year. These new Science Schools have been three years in building, have cost 42,000*l.*, and will cost about

8,000*l.* more before they are finished. They are intended to be connected by an arcade with another similar block of Museums and Offices, also facing the same side of the Exhibition Road. The vacant space opposite is to be appropriated to a Natural History Museum, which is to be joined to the existing buildings by a sort of Bridge of Sighs crossing the road at the upper end of the Science Schools. The premium for a design for the Natural History Museum had been awarded to Captain Fowke, but after his death Mr. Waterhouse was requested to prepare another design, which will be Gothic, and thus, it is to be feared, a violent and dangerous contrast to the South Kensington buildings—a contrast which Captain Fowke had carefully avoided.

The new Science Schools are built of brick founded on concrete, the lowest and the highest storeys being faced with blocks of terra-cotta. The treatment of the body of the building is red brick facing dressed with terra-cotta in plain and moulded blocks, and the first thing which strikes the eye is the deep rich red of the brickwork and the play of colour in its surface, rendering it agreeable to look upon and redeeming it from monotony. There is still some softness in it on the most glaring day, and still some warmth on the most gloomy. The bricks are Fareham bricks, such as have been used in St. Thomas's Hospital, and the rich colour is produced by rubbing their outer surfaces smooth to a gauge on a revolving metal table, a process which about doubles their cost. The courses are laid with great nicety; common mortar is not spread upon them with a trowel, but each brick is dipped in a tub of a fine liquid compound, and then placed in position. Colonel Scott, C.B., R.E., is the architect of the building, and his chief idea in designing the Exhibition Road front has been to obtain a good bold contrast of light and shadow. To this end, parts of the building are brought into massive projection. The wings come forward and are tied together by terra-cotta arcades above and below. The upper part of the lower arcade forms a balcony to the first floor, and the interiors of its arches are filled in with majolica, which brightens the deep recesses and throws light into the rooms. In the terra-cotta columns which support this arcade are three ornamented drums. The subject of the design on each of the drums is the Seven Ages of Man; each is the same as the others, but is slightly turned, so that from one point of view we can see the whole design, from the infant on the uppermost drum to the aged man on the lowest. The drums are separated by spaces of moulded shaft, on which is laid a branch of the small-leaved laurel. The window openings of the second and third floor are bordered with terra-cotta. The under part of the upper arcade which runs along the highest storey is well supported and richly worked, and one has to look close to notice the want of that sharpness which is so great a beauty in stone. This topmost storey is faced entirely with terra-cotta, which causes it to sit rather heavily and awkwardly on the abruptly-terminated

brickwork of the body of the building. The eye requires that the brickwork should have been carried to the summit in places, and this need is the fault of the building. The pediments of the wings are to be filled in with encaustic tesseræ, and the spaces left bare under the windows of the ground floor will be ornamented with iron grilles. This building is an excellent example of the effective use which may be made of terra-cotta in conjunction with brickwork.—*Times.*

THE INTERNATIONAL EXHIBITION.

THE first of "a series of International Exhibitions of the Fine Arts and of Industry" was opened at South Kensington on May 1 by the Prince of Wales, on behalf of the Queen, and was made the occasion of an imposing State pageant. To most people Great Exhibitions have become somewhat trite and even tiresome. That of 1851 was new, instructive, and delightful. When this glittering casket and the treasures it contained passed away, one or more Crystal Palaces were established among us in permanence; and about nine years ago there arose another Great Exhibition, displaying two vast domes of glass each larger than the dome of St. Peter's. That, too, was successful; but the parent Exhibition was copied without being improved upon both at home and abroad, until the plan which 20 years ago was so novel and agreeable seemed worked-out and wearisome. Other causes contributed to the growing unpopularity of Great Exhibitions fashioned after the first model. Manufacturers and inventors found it exceedingly expensive to exhibit, while, after incurring the expense, they might chance to be robbed of the merit due to them by some accident or prejudice. Having regard to these conditions, the Royal Commissioners of 1851, by whom the present Exhibition is promoted, wisely determined to alter materially the conditions on which it and its successors should be based. To begin, this is not a "Great" Exhibition in the conventional sense. It is not a Noah's Ark into which all industries, products, and inventions are admitted, classified, and hurriedly placed according to their supposed merit. The manufactures now shown are confined to woollens, worsteds, and pottery. Next year two or three other industries will have their turn. Every year, however, the Fine Arts, giving that phrase a liberal interpretation, will be represented; so will works of scientific invention and horticulture. Lastly, with a view to ease both the minds and pockets of Exhibitors, the Royal Commissioners have discarded the system of medals, certificates, and prizes; they appoint in each department a Committee of Taste, who, as at the Royal Academy, decide whether, having regard to the space at their command, the objects sent are worthy of admission; and every object admitted then stands on its own merits, no personal, trade, or international

being created by awards which may be just, but which, through accident or bias, have often hitherto been unsatisfactory.

It is necessary to explain at starting how the new Exhibition departs from tradition, not aiming, like its predecessors, to contain a little—or rather a good deal—of everything, and being therefore much less bewildering. The building itself, too, is utterly unlike those of 1851 and 1862. There is no transept, glowing in the sun; there is no nave, and there are no domes, large or small. Take the gardens of the Royal Horticultural Society for a quadrangle, and they make a magnificent one; imagine galleries of one and two storeys as quadrants. connected with the Albert Hall and utilising the arcades of the Horticultural Society with a portion of the old galleries of the Exhibition of 1862 upon the south, and you have a rough idea of the International Exhibition of 1871.—*Ibid.*

STEAM TRANSPORTS IN THE INTERNATIONAL EXHIBITION.

In no direction are there greater efforts making at the present time than in the application of Steam to travelling on common roads, and to the transit of goods and materials. Among the Traction Engines, Messrs. Robey, of Lincoln, had a capital road steamer, fitted with Thompson's india-rubber wheel tyres. The power of the example contributed to the Exhibition is eight horse-power nominal, its cylinders being 6¼ in. in diameter; the stroke 9 in.; revolutions 220 per minute. The furnace and pot-boiler have a vertical arrangement. Although of so small nominal power, it is said, nevertheless, to be capable of developing, with the gearing, about 40-horse power, by employing steam of a very high pressure, and running at a very quick speed. The boiler is made of the very best steel plates, and is double-rivetted throughout, the utmost care being taken in its manufacture. It is tested by hydraulic pressure to 300 lb. per square inch, and afterwards worked under steam of about 180 lb. Before leaving the works the extra safety valve is set to blow off at 150 lb., and as this is locked up out of reach of the driver a greater pressure than this cannot be attained. This leaves a wide margin, as the bursting pressure of the boiler is about 900 lb. This class of engine is intended for light goods or passenger traffic. It will draw a heavy train, say 20 tons, on ordinary roads, at from 2½ to 6 miles per hour, or an omnibus or a light luggage van at from 4 to 8 miles. The engine is at all times under control, and can be guided, stopped, or started with the greatest facility. One of the objections raised against the use of such engines on common roads has been the danger from sparks thrown off from the funnel; this has been completely obviated in Mr. Robey's engines by an improved spark-catching chimney, which effectually arrests and extinguishes the sparks, and not having anything on it which can get out of order or wear rapidly away, makes a valuable and permanent improvement.

These road steamers are daily coming into more and more general use, especially in countries where the railway accommodation is limited, and to none more than to this persevering firm will the steam-road work of the future be more thoroughly indebted.

Messrs. Aveling and Porter also exhibited a Locomotive Steam Engine constructed for drawing heavy loads over ordinary roads. It is constructed with the special view of being used for military purposes, and it has been their object to combine the greatest practical strength in the design with a weight not exceeding that of one of the 64-pounder guns forming its train when passing over pontoon or other temporary bridges. It is of 6-horse power nominal, with a single cylinder 7¾ inches in diameter; this is jacketed and placed upon the forward part of the boiler to prevent priming in steep ascents. The steam is taken into the cylinder from the dome or steam chest on the top of the jacket without the intervention of steam pipes either inside or outside the boiler. From the crank shaft the motion is taken by spur-gear through the second motion shaft to the spur-wheel attached to the driving axle. These three shafts are fixed one above another in a vertical frame formed out of the prolonged ends or horn plates of the boiler, an arrangement which gives a strong and light bearing in the most convenient position for the gearing, and avoids the periodical annoyance of leaky bolt-holes inseparable from the ordinary cast-iron brackets mounted on the top of the boiler. The driving wheels are ten inches wide on the face, and five feet in diameter, made of wrought iron, and fitted with simple compensating motion, by which the driver is enabled to turn the sharpest curves without disconnecting either wheel. The front wheels are of wood, and 3½ ft. by 6 in. The crank shaft carries a fly wheel, and thus enables the engine to drive fixed machinery when not otherwise employed. The boiler is of the locomotive type, and the tender carries a fair supply of water and fuel. The steering is effected from the driver's footplate, and the entire engine is under the management of one person. The average load for the engine on good roads may be put down at twice its own weight up inclines of 1 in 12, and thrice its weight on a level. In some experiments made last year at Chatham with an almost identical engine, the "Steam Sapper No. 1," the load drawn up a gradient of 1 in 11 was equivalent to 2 8-10ths of its own weight; but this was taxing the engine beyond what it is deemed advisable for constant working. The locomotive with fuel, water, and driver weighs five tons.—*Standard.*

WOOLLEN MACHINES IN THE INTERNATIONAL EXHIBITION.

In the department of machinery in motion was a set of Looms by Messrs. H. R. Willis and Co., of Coventry, for producing the rich and elegant Axminster chenille hearth-rugs. These looms

were three in number, the first being the weft loom, in which the many-coloured weft is produced in broad strips. As each length is completed it is taken to the second or cutting loom, where it is passed under a rapidly revolving cylinder, the surface of which is studded with rows of spoon-shaped blades. As the piece of weft is drawn under this cylinder the knives cut it into narrow strips, which are wound upon a kind of shuttle about 30 inches long. This is then transferred to the setting loom, which is a hand-machine, and where the operator converts it into rugs of elegant design. The process of manufacturing these rugs is exceedingly slow and tedious, as compared with those carried on in the adjacent power-looms for carpets and lighter fabrics. The results, however, are very beautiful, the velvet-like pile of the chenille rugs, and the blending of vivid colours, combining to produce a rich and pleasing effect.

We next come to the Cloth-Fulling machine of Mr. James Ferrabee, of Brimscombe, which had a pressing and retarding lid attached to the axis of the top cylinder. Mr. Ferrabee has introduced in his apparatus an excellent plan of running the cloth double, as well as a good knocking-off arrangement. The cloth is drawn through metal ferrules of different sizes, to regulate its length. Mr. Ferrabee had also a new driving friction-gear, by means of which the fulling cylinder is caused to stop instantaneously should the cloth become entangled. The cloth on leaving the fulling machine is rough, and has a hard surface, which requires bringing up by dressing with the teasel. For this purpose Mr. Ferrabee has designed a dressing-machine, which possesses several advantages over the older kinds of apparatus. Two cylinders, of different diameters, are made to revolve in opposite directions. Wide spaces are left between the teasel-boards on the larger cylinder to insure the beating action of the old upright dressing-machine. The smaller cylinder has no spaces, and each is driven independently, and may be worked separately. The larger cylinder revolves in the same direction as that in which the cloth travels, whilst the smaller one has an opposite motion. The latter cylinder touches the cloth in one place only, and the pressure of the teasels is regulated by an eccentric breast-work. The larger cylinder touches the cloth in two places, and the action of the teasels is also capable of adjustment. The cloth is fed to the rolls by mechanical means, the degree of tension being regulated manually. The material is extended laterally by expanding rolls, by which means a smooth surface is presented to the teasels. The machine is stated to be capable of dressing from 50 to 60 yards of fine broadcloth in about 12 hours with a considerable economy in other respects, besides time.

The engine destined to communicate motion to the models and apparatus was a machine on Wolf's system, of 16-horse power, with a single steam-chest for the two cylinders, placed one in prolongation of the other, so that the two pistons are on the same

piston rod. The air-pump also had a common motion with the feed-pump, and the admission of steam was regulated by one of Porter's slide-valves. This prime-mover, extremely regular and uniform in work, was exhibited by Messrs. C. and T. J. Pattison, of Naples, as also a contrifugal pump, a garden-engine, a locomotive (without external tubes), and a semi-fixed vertical engine of very small power. There was also a fixed engine of eight horse-power, manufactured at the Oretea foundry in Palermo: Mr. W. Theis, the constructor, has introduced in this machine the automatic expansion gear, directed by a regulator acting on the balance weight of a Stephenson's half-sector; nevertheless it was very imperfect in its motions, and notwithstanding the counterpoise attached to the crank, there was considerable vibration. From the same foundry there were exhibited a semi-fixed engine with a Tuxford regulator, and a little steam crane, with inclined fixed cylinder (on Taylor's system).—*Mechanics' Magazine.*

DIAMOND BORING MACHINE.

In reference to the diamond boring machine of Capt. Beaumont, in use in the Cleveland district, it may be as well to remind our readers that this application of the cutting power of diamonds is due to a Swiss engineer, Mr. Leschot, whose boring machine has been in use for several years. In the lead-mining districts of Missouri, it is regularly applied to the same purpose of prospecting for lead in the Silurian limestones, and the results obtained are similar to those described by us. Another interesting application of the same material is furnished in the dressing of millstones. The intense hardness of the cutting material used —the hard, black, uncleavable diamond—is such, that a single diamond has been employed for more than a year dressing a pair of French burr millstones daily, without perceptible wear or diminishing of cutting power.—*Athenæum.*

NUGGETS OF GOLD.

Mr. W. Skey, writing from the Laboratory of the Geological Survey, New Zealand, directs attention to the *Athenæum*, July 22, 1871, in which, quoting from Mr. Wilkinson's address before the Royal Society of Victoria, credit is given him for observing the deposition of gold from its solutions upon already formed nuggets, thus indicating the probable mode of the formation of nuggets. It appears that Mr. Wilkinson stated that he had merely verified the correctness of the assertion and experiments of Mr. Daintree, who was the first to observe this remarkable fact, and to publish it. Mr. Daintree is now in England, and is engaged on a series of investigations to determine, if possible, under what conditions silver can be deposited simultaneously

with gold, and thus further to illustrate the conditions under which the silvery gold of some parts of New Zealand and other gold-fields may have been produced.—*Athenæum.*

THE PATENT CATOPTRIC LAMP.

Mr. Skelton, of Essex Street, Strand, has invented and patented a new description of lamp for street lighting. The principle of the invention is the application of reflectors, in order to bend down and utilise the amount of light which is at present wasted by upward radiation. It is manifest that the rays of light from a street lamp which now strike the eye of a spectator placed on the ground are only a small portion of those actually emitted by the flames. The rays which pass through the upper portions of the sides of the lantern, or through its sloping roof, are entirely dissipated; or at best, if partially and imperfectly reflected by clouds or atmospheric particles, become visible only in the form of the red glow which overhangs a distant town. Mr. Skelton calculates that about two-thirds of the light given by the gas flame are in this way lost and he has arranged strips of looking-glass in such a way that the loss will be effectually prevented. The upper half of each side of the lamp and the whole of each side of the sloping roof are occupied by a frame, in which the strips are placed with their reflecting surfaces downwards, in a manner somewhat analogous to the laths of a Venetian blind. The precise character of the effect produced will depend upon the distance of the strips apart, upon their width, and upon their angle of inclination; but the general result is, subject to small variations, that the street receives three times as much light as would fall upon it through lanterns of the ordinary kind. The frames holding the strips are glazed on both sides, and made dust-proof, so that the mirrors will not themselves become soiled or tarnished, and the reflector as a whole can be cleaned in the ordinary way, by simply wiping the glass. The price of the apparatus will be very moderate, and Mr. Skelton estimates that the illuminating power of any given quantity of gas may be trebled, at an increase of about 5 per cent. on the present annual cost. The plan is equally applicable to every form of lamp, and the patent includes the application of prismatic reflectors, which would present advantages in certain cases.—*Times.*

GEORGE'S CALORIGEN.

In this Stove, whether heated by gas, or by coal or other fuel, the cold air from without is conducted into the room by a pipe, which is continued through the interior of the stove, in a coil, to the top, where the pipe ends in an opening through which the pure warmed air escapes into the room. The air for gas combustion also enters the room by a pipe from without, and the products of combustion have a similar exit. There is also an

exit pipe for this purpose in the stove for coal or other fuel. The stove is "so constructed," says the patentee, "as to retain a deposit of carbon, thereby preventing the absorption of oxygen, and emission of hydrogen and oxide of carbon, some of the deleterious products resulting from the use of cast-iron stoves. It works with a very small amount of fuel—20 lb. of coal for sixteen hours."—*Builder*.

CLAYTON'S BRICK-MAKING MACHINE.

ONE of the most noteworthy mechanical objects, features in the International Exhibition, is to be found in the annexe containing the pottery machinery. This is the series of Brick and Tile-making machines exhibited by Messrs H. Clayton, Son, and Howlett, of the Atlas Works, Woodfield Road, Harrow Road, London. Among these is Messrs. Clayton's combined three-process brickmaking machine, in which the processes of crushing, pugging, and moulding are carried on simultaneously. This machine is more especially applicable to the working of argillaceous clays, earths, marls, &c.; its action may be briefly described as follows: the clay to be made into bricks is wheeled up an incline and fed into the hopper of the machine. In this hopper revolves a shaft on which are keyed several small knives, which cut up the clay previous to its being crushed, and regulate its feed to the crushing rollers. The clay next passes through a pair of powerful crushing rollers which effectually reduce any stones or hard lumps of clay that may enter the hopper. The crushing rollers are mounted on strong wrought-iron shafts—one of them is arranged to run in shifting bearings, so that by means of set screws it may be moved to or from its fellow, to regulate the amount or fineness of the crushing.

The clay thus partially prepared passes into the horizontal pug cylinder, where it is thoroughly mixed and incorporated by the pug knives or blades, which are fixed upon a massive central shaft rotating therein. The knives or blades are arranged to form sections of an Archimedean screw, and at the same time as they are cutting, turning over, and pugging the clay, they force it towards the further end of the pug cylinder, where it is received by the feeding rollers (of which a pair is arranged on each side of the machine), which continually express the clay through the moulds in long consolidated, clean, smooth, square streams of the length and width of a brick, which are subsequently subdivided into the thickness required, by a cutting apparatus.

The dies or moulding orifices, so well-known as Clayton's patent rotary-orifice dies, are worthy of notice. They are constructed with revolving sides, which are kept lubricated with water from a small reservoir; as will be readily understood, all friction at the sides and angles of the stream of clay is done away with, and sharp, clean arrises are produced, a result not generally accomplished by other constructions of dies. Of course brickwork built of bricks with good square angles is far superior in ap-

pearance to that executed with ordinary round-edged bricks, such as are made by means of some kinds of dies, although they are lubricated or heated by steam. It is important to remark that simply by changing the moulding orifices for others suitable, or by change of the strain bars of the cutting apparatus, all kinds and shapes of solid, perforated, and tubular bricks may be made by this machine, as also splay, bevel, bullnose, squint, and plinth bricks, copings, paving tiles, and the ordinary sizes of agricultural drain pipes. The machine is mounted upon a strong foundation plate, by which the trouble and expense of masonry foundations are avoided, and durability of the working parts is secured.

With regard to the quality of the bricks made by Messrs. Clayton's machine, we cannot do better than summarise a series of comparative experiments which were made for the Commissioners of Sewers. These experiments most conclusively and satisfactorily establish the power of the Clayton bricks to resist a crushing pressure—the strain to which they are subject in practice. All the bricks were bedded singly and without previous preparation upon a thickness of felt, and laid upon an iron-faced plate. The following table shows the bricks tested, together with the average results:—

Class of Brick.	Pressure required to fracture in tons.	Pressure required to crush in tons.
Good London Grey stocks	12 00	14·00
Best paviours	14·06	23 00
Red bricks partially burned	13·75	25·05
Red bricks, ordinary quality	13·00	26·25
3 White bricks (Clayton & Co's machine)	17·05	41·05
4 White bricks (do.) 2nd test	16 25	41·60

These results are conclusive and convincing, and we need only add that, in the machine itself, both design and workmanship are equally excellent and satisfactory.—*Mechanics' Magazine.*

IMPROVED WOODEN PAVEMENT.

Any improved system in the pavement of our streets is worthy of consideration. By the sanction of the Commissioners of Sewers a new principle, already successfully adopted in the United States, in Paris, St. Petersburg, and Vienna, has been lately introduced, and is now on its trial at the south end of Bartholomew Lane. The pavement is constructed of wood, and some idea of its claims to superiority over similar pavements may be formed from its pretensions to these advantages—absence of slip, noiselessness, elasticity, durability, and an even surface at all times. The construction of the pavement varies according to the traffic and other circumstances. In Bartholomew Lane it is laid on a bed of sand, of sufficient depth to form a good grade, say from 1 to 2 inches; on that a flooring is placed, which con-

exit pipe for this purpose in the stove for coal or other fuel. The stove is "so constructed," says the patentee, "as to retain a deposit of carbon, thereby preventing the absorption of oxygen, and emission of hydrogen and oxide of carbon, some of the deleterious products resulting from the use of cast-iron stoves. It works with a very small amount of fuel—20 lb. of coal for sixteen hours."—*Builder.*

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sists of two thicknesses, one laid horizontally, the other transversely, each thickness consisting of a $\frac{3}{4}$ in. board prepared with tar. Upon these boards blocks of wood measuring $9 \times 3 \times 5$ in. are placed, and between each row of blocks a strip of wood $1 \times \frac{3}{4}$ in. is nailed to the flooring, the object being to steady the blocks in their places during construction; after being thus laid, the spaces or joints are filled with hot gravel, upon which hot tar or pitch is poured. This is rammed tight home and again repeated until the spaces are filled up. Subsequently another application of tar is made over the surface, on which a dressing of fine gravel is thrown; when dried the pavement is complete. The 400 square yards now completed in Bartholomew Lane are sufficient to judge of this new experiment in London. Its success remains to be proved.—*Times.*

A NEW MOTIVE POWER.

A CITIZEN of New Orleans has been so successful in experimenting with fluid gas of ammonia as a motive power, that he claims that there is a probability that it may supersede horse power on street railroads. Liquified ammonia, when subjected to a heat of 60 degrees Fahrenheit, turns to a vapour, which produces a pressure of 60 lbs. to the square inch. This pressure is applied like steam, and is subject to the same controlling influences. When intended to be used for the purpose of propulsion, the ammonia is poured into a system of tubes, deposited in a tank of water in such a way that the gas which passes through the cylinder, instead of escaping into the open air, may be carried through the exhaust pipe, and be absorbed by the water. In this manner the ammoniated water is preserved, and being reinstilled, is capable of being used over again several thousand times, wearing out only at the rate of 25 per cent. per annum. The gas is so readily absorbed by the water that it prevents any disagreeable smell or noise of concussion with the air. At the end of each trip the tubes are refilled from a stationary reservoir of liquid ammonia, and during the journey the heat lost by the tubes is acquired by the water in the tank, which reimparts it, and prevents the ammonia from falling below the boiling temperature. The report of the examining committee, headed by General Beauregard, approves of the invention in terms which are too indefinite to be conclusive.—*New York Times.*

TURBINE WHEEL.

THERE is in the town of Meriden, Conn., a Leffel Double Turbine Wheel, running under 240ft. fall and driving a manufactory. It uses only about one-half of a square inch of water, and runs at the marvellous speed of 3,000 revolutions per minute, or 50 revolutions per second, which is by far the most rapid rate of motion ever imparted to a water wheel. This is, also, beyond comparison the greatest fall applied to the propulsion of a wheel in America.—*Scientific American.*

Natural Philosophy.

THE TIDES.

SIR WILLIAM THOMSON has read to the British Association the Report of the Tidal Committee for the year. This was, generally speaking, of a very technical character, but it contained an interesting passage with regard to the degree of elastic yielding which the solid earth experiences under the tide-generating influences of the sun and moon. It is quite certain that the solid earth does yield to some degree. It has long been a favourite assumption of geologists that the earth consists of a shell of solid rock from 20 to 50 miles in thickness, enclosing an interior filled with melted material. lava, metals, &c. This hypothesis is now shown to be absolutely untenable, because, if it were true, the solid crust would yield with almost as much freedom (on account of its thinness and great area) as if it were perfectly liquid. Thus the boundary of the solid earth would rise and fall under the tide-generating influences, so as to leave no sensible differences to be marked by the water rising and falling relatively to the solid; showing that if the earth as a whole had an average degree of rigidity equal to that of glass, the tides would be very much diminished from the magnitude which they would possess on a perfectly rigid globe, with water like that of our seas upon it. This consideration, the committee reports, makes it probable that the earth has considerably more average rigidity than a globe of glass of the same size. The mathematical calculation shows a somewhat startling result, to the effect that a globe of glass of the same size as the earth, if throughout exactly of the same rigidity as glass on a smaller scale, would yield like an india-rubber ball to the tide-generating influences, thus leaving very little opportunity for change in the relative heights of water and land. The precise agreement of the actual tidal movement with estimates founded on the supposition of a perfectly rigid globe, renders it probable that the earth is in reality vastly more rigid as a whole than any specimens of surface rock that had been experimented upon in laboratories. Dr. Soule, ten years ago, in speaking on this subject, had suggested that probably the great pressure in the interior produced in the material, which might be of the same substance as surface rocks, a greatly increased rigidity in positions at great depths below the surface. Now that observations from so low a latitude as that of Cat Island are available for comparison with those of the tides of our own coast, the committee believes it may advance hopefully to this part of the inquiry, which, accordingly, it proposes to make a primary object in the calculations next to be undertaken.

PHENOMENA OF FROST.

Professor James Thomson, of Belfast, has read to the British Association a paper on the ascent of water against gravity during frost, instead of its freezing in the pores of moist earth. The paper was in continuation of one read in 1862, on the disintegration of stones and earth by frost, and it set forth some remarkable instances of the action referred to. In one of these the water from a pond in a garden had, in time of frost, raised itself to heights of from four to six inches above the water surface level of the pond, by permeating the earth bank formed of decomposed granite, which it kept thoroughly wet, and out of the upper surface of which it was made to ascend by the frost, so as to freeze as continuous columns of transparent ice rather than in the earth pores. From day to day, during the frost, the earth remained unfrozen, while a thick slab of columnar ice formed itself by new water coming up from the pond and insinuating itself forcibly under the bases of the ice columns so as to freeze there, pushing them up, not by hydraulic pressure, but on principles which, while seeming previously not to have been noticed, appear to involve considerations of scientific interest, and to afford scope for further experimental and theoretical researches.

SECULAR COOLING AND FIGURE OF THE EARTH.

Professor Clifford has given to the British Association "A Note on the Secular Cooling and the Figure of the Earth." One line of argument by which Sir W. Thomson had endeavoured to prove that the earth could not have been habitable for more than 100,000,000 years was found on the secular cooling of the earth. He proves that after 100,000,000 years from the beginning of the cooling (starting with the earth as a mass of melted rock), the rate of increase of temperature in going downwards would be about what we find it to be—1° Fahr. in 50 feet. Dr. Calvert, in one of the other sections, had endeavoured to prove that certain elementary forms of life can survive a temperature of over 320° Fahr. If this be so, we are at liberty to suppose that the sea had a temperature of about 320° at the beginning of the period. This, Prof. Clifford found would only increase the time required by 8 per cent., as compared with an initial temperature of 50°. Another of Sir William's arguments was founded on the friction of the tides. The earth must have been originally rotating much faster than now, its rotation being gradually diminished by tidal friction. The shape of the earth at present is so nearly that which it would have assumed in solidifying at its present rate of rotation, that we cannot allow more than 100,000,000 years. Now it had been suggested (in the first instance by Playfair) that the earth, if initially solid and having any shape whatever, would ultimately come to its present shape; that, on account of its vast size, it would behave like a soft body.

Sir W. Thomson said it had always appeared to him that the temperature of the surface of the earth must depend solely on the temperature ot the sun and of surrounding space. If the sun was so hot as to give a temperature of 320° Fahr. for many million years, the state of things imagined by Dr. Calvert may have existed as far as physical reasons are concerned. It was satisfactory to find, as Prof. Clifford had shown, that the time required for the earth's cooling was only affected 8 per cent. by such a supposition. As regarded the other point raised, he did not know whether Prof. Clifford argued from elastic yielding, or from detrition. Considering first detrition, on the supposition that the earth did not yield elastically: if the earth had solidified 300,000,000 years ago, what would have been the changes produced by landslips, wearing down by rivers, and other forms of detrition? The earth would have initially a much greater velocity of rotation than at present, and therefore a much greater protuberance at the equator. As the rotation diminished, the sea would run to the poles, and leave a great mountain all round the equator, cutting off all communication between the northern and southern seas. Could this result in the present distribution of land and water? Have we not the evidence of mountains five miles high before us, and have we the right to say that a more gradual slope amounting to ten miles could not survive? The other question, of elastic yielding, is answered in the investigation regarding the tides on an elastic globe. The very existence of the tides proves a considerable degree of rigidity against the deforming influence of the tide-generating forces of the sun and moon; and the accuracy with which calculations of precision and mutation, based on the hypothesis of absolute rigidity, agree with observation, give us very strong evidence of a rigidity so great that the elastic yielding, though not quite insensible, will be very small in proportion to the whole yielding which a fluid globe would exhibit under the action of the same forces. It seems to be established on scientific evidence that the earth cannot have been so far cooled and consolidated as to be fit for such life as we have any samples of at a period of a thousand million years ago, for the one reason that, if this had been the case, its condition now would be a condition proceeding from that of a rigid globe with a protuberance twenty, thirty, or forty miles high at the equator; the substance of which would, in the first place, produce prodigious crushing and disturbance, and afterwards nothing like the present distribution of land and water. This argument gives such a limit as a thousand million years, but other arguments give a closer limit.

SURFACE MOVEMENTS OF THE EARTH.

M. DE BOTELLO describes two contemporary upheavals of the earth's surface, entirely authentic. In the province of Jamora it

is observed that, from the village of Villar don Diego, it is now possible to see the upper half of the church steeple of Renifarzes, a village in the province of Valladovid; whereas 23 years ago, in 1847, the summit of this steeple could only just be perceived. The same thing occurs to the same degree, and under the same circumstances, in the province of Alava; there it is observed that, from the village of Salvatierra. the whole of the village of Salduende can now be seen, while in 1847 the vane of the steeple could hardly be perceived. The four points mentioned are on the line which would pass by Burgos, and in the direction W. 28° 39′ S., to E. 28° 39′ N., that is to say, sensibly parallel to the system of the Sanserrois. A distance of about 140 miles separates the extreme points of the line of upheaval.

ARBORESCENCE IN MINERAL LIFE.

PROFESSOR TYNDALL, in a lecture on "Ice, Water, Vapour, and Air," delivered at the Royal Institution, has shown some beautiful examples of crystallisation by making salts and metals deposit crystals from small quantities of their solutions placed in the electric microscope. Silver and lead ferns appeared as if endowed with life; crystals of ferrocyanide of potassium were seen growing, in pulsating waves, as if the crystallising force had to accumulate strength every few seconds to overcome some resistance—a phenomenon which has not yet, it is believed, been investigated by men of science; at all events, the lecturer said that it was a novel observation to him. Crystals of chloride of ammonium grew like delicate and graceful ferns. Finally, the lecturer showed how, beam by beam, nature builds up the crystals of ice, every portion of the structure being singularly beautiful; and he melted a thin slab of ice in the electric microscope, so that the observers could see on the screen the star-like forms of which it is built up.

VALUE OF FUEL.

IN the *Comptes Rendus* of the Academy of Sciences for December 4, Drs. Scheurer-Kestner and C. Meunier continue their researches on Coal and Fuel. In the present paper they deal with lignites of France. They arrive at the result that it is impossible to draw satisfactory conclusions as to the heat value of a fuel from its elementary composition.

UNDERGROUND TEMPERATURE.

PROFESSOR EVERETT has read to the British Association the Report of the Committee on Underground Temperature, of which the following is an abstract:—

"The intended boring at the bottom of Rosebridge Colliery has not been executed, recent occurrences in a neighbouring pit having given the manager reason to fear an irruption of water

in the event of such a boring being made. Careful observations of temperature have been taken by the engineers of the Alpine tunnel under Mont Fréjus (commonly called the Mont Cenis Tunnel). The highest temperature in the rocks excavated was found directly under the crest of the mountain, which is quite a mile overhead. This temperature was 85·1 deg. Fahrenheit; the mean annual temperature of the crest over it being estimated, from comparison with observed temperatures at both higher and lower levels (San Theodule and Turin), at 27·3 deg. Fahrenheit. Assuming this estimate to be correct, the increase of temperature downwards is at the rate of 1 deg. in 93 feet, which, by applying a conjectural correction for the convexity of the surface, is reduced to about 1 deg in 81 feet as the corresponding rate under a level surface. This is about the rate at Dukinfield Colliery, and is much slower than the average rate observed elsewhere. The rocks are extremely uniform, highly metamorphosed, and inclined at a steep angle. They contain silica as a very large ingredient. They are not faulted to any extent, and are very free from water. It is proposed to sink two bores, to the depth of from 50 to 100 feet, at the summit, and another point of the surface over the tunnel, with the view of removing the uncertainty which at present exists as to the surface temperature.

Mr. G. J Symons has repeated his observations at every fiftieth foot depth in the water of the Kentish Town well, between the depths of 350 and 1,100 feet, the surface of the water being at the depth of about 210 feet. The observations which have been repeated are thus completely free from the disturbing effect of seasonal changes. The results obtained agreed closely with those previously found, and show between these depths a rate of 1 deg. in 54 feet, which, from the estimated mean temperature of the surface of the ground, appears to be also very approximately the mean rate for the whole 1,100 feet. The soil, from 325 to 910 feet of depth, consists mainly of chalk and marl, and shows a mean rate of 1 deg in 56 feet. From 910 to 1,100 feet, it consists of sandy marl, sand and clay, and shows a mean increase of 1 deg. in 54 feet. The former of these is in remarkably close agreement with very trustworthy determinations made by Walferden from observations in the chalk of the Paris basin. These are as follows:—Puits de Grenelle, Paris, depth, 400 metres; rate, 1 deg., F. in 56·9 feet. Well at Military School, Paris, depth, 173 metres; rate, 1 deg. F. in 56·2 feet. Well at St. Andre, 50 miles west of Paris, depth, 263 metres; rate, 1 deg. F. in 56·4 feet. General Helmersen, of the Mining College, St Petersburg, informs the secretary that in sinking a well to the depth of 540 feet at Yakoutsk, in Siberia, the soil was found to be frozen, probably to the depth of 700 feet. The rate of increase from 100 to 540 feet was 1 deg. F. in 52 feet. A new pattern of thermometer has recently been constructed for the committee, which promises to be of great service. It is a *maximum* thermometer on Negretti's principle, adapted to be

used in a vertical position with the bulb at the top. The contraction in the neck prevents mercury from passing into the stem when the instrument receives moderate concussions. Before taking a reading, the instrument must be gently inclined so as to allow all the mercury in the stem to run together into one column near the neck. On restoring the thermometer to the erect position, the united column will flow to the other end of the tube (that is, the end furthest from the bulb), and it is from this end that the graduations begin. It is set for a fresh observation by holding it in the inverted position, and tapping it on the palm of the hand. This instrument, like that heretofore used by the committee, is protected against pressure by an outer case of glass, hermetically sealed.

SOUNDS FROM JEBEL NAGUS.

CAPTAIN H. S. PALMER, R.E., has read to the British Association an interesting paper on certain noises which are heard proceeding from Jebel Nagus, a sand slope in a long low range of mountains which stretches northward along the coast on the western shore of the Peninsula of Sinai:—

"The slope is about 200 feet high, and almost triangular in shape, 80 yards wide at its base, and narrowing towards the top, where it runs off into three or four small gullies. The sand appears to be that of the neighbouring desert, derived in the first place from the waste of the sandstone rocks, and then conveyed to its position by the drifting action of high winds. Its grains are large, and consist entirely of quartz. The sand of the slope is so pure and fine, and in its usual condition so perfectly dry, and lies at so high an angle (nearly 39 degs.) with the horizon as to be set in motion by the slightest cause. When any considerable quantity is thus in motion, rolling slowly down the slope like some viscous fluid, there is heard the singular acoustic phenomenon from which the mountain derives its name —at first a deep, swelling, vibratory moan, rising gradually to a dull roar, loud enough when at its height to be almost startling, and then as gradually dying away till the sand ceases to roll. The sound is difficult to describe exactly; it is not metallic, not like that of a bell, nor yet that of a nagus. Perhaps the very harshest note of an Æolian harp, or the sound produced by rubbing the finger round the wet rim of a deep-toned finger-glass most closely resembles it, save that there is less music in the sound of this rolling sand. It may also be likened to the noise produced by air rushing into the mouth of an empty metal flask or bottle. Sometimes it almost approaches the roar of thunder, and sometimes it resembles the deeper notes of violoncello or the hum of a humming-top. Hot surface sand was always more productive of sound than the cooler layers underneath. Theories which had been proposed—that the sound may proceed from the movement of the sand over hollow rocks, from

its falling into cavities, from the wind acting on thin plates of mica (which do not exist) in the surrounding rocks, from volcanic causes, and so on—must, Captain Palmer thought, be dismissed as untenable. The experiments which he had made appeared to him to demonstrate in the clearest manner that it is merely the moving surface sand which is sonorous; and in this opinion he believed nearly all previous visitors to Jebel Nagus concurred."

M. Faye has been led by consideration of the numerous observations of sun spots, made by M. Carrington, to the following conclusions:—

1. That Zöllner's theory which views the sun as a solid body covered with a layer of incandescent liquid, is entirely improbable, and, indeed, impossible.

2. The speed of rotation of any point whatever on the sun's surface is always expressed by one and the same formula.

3. There do not exist on the sun's surface any sensible currents which are at all analogous to the "trade winds."

4. The absolute absence of currents is only explicable by the presence everywhere of ascending currents of great intensity proceeding from the sun's centre to its surface.

5. The existence of such currents is an imperative proof that the body of the sun must be in a gaseous state, and is an immense sphere of aeroform matter, of an enormous temperature, but which is continually cooling by the action of the ascending currents.

6. The sun is absolutely spherical.

PROTUBERANCES OF THE SUN.

In some observations made at the Observatory at Palermo, Prof. Tacchini, after mentioning the six types of forms of the protuberances observed by him at the time of the eclipse on Dec. 22 last, gives the observations made on March 9 and 11 last, in four diagrams of beautiful protuberances, demonstrating the precision with which these peculiarities of the border of the sun can be seen. The drawing of March 9 presents a series of neat, lucid threads, very distinct one from the other, and ending in acute points. Prof. Tacchini says that the phenomenon could be seen so clearly that the threads or jets could be easily numbered; the upper part of them is red, and the lower of a bright flame colour.

In the drawings of the 11th there are two thin luminous small threads, very near and normal to the border, curved at their upper extremity and resembling two hooks. These also appeared very distinct, precise, and of an extraordinary and intense luminosity. On other points of the border were seen protuberances which gave no sign whatever of luminous fila-

ments, but, on the contrary. were quite vapourous. The Professor concludes his observations as follows :—

1st. That the protuberances are divided into two great categories—*filamentous* and *simply vaporous*.

2nd. That in the great refractor of *Merz*, the protuberances are observed with the greatest precision and clearness.

3rd. That with powerful instruments the distinction of the two categories is quite evident, while with small instruments the observer may fall into the error of attributing a common structure, without distinction, to the protuberances in general, which explains the differences in the various observations made with ordinary instruments.

4th. That the whole of the border of the sun is a series of flames.

SOLAR ECLIPSES.

Mr. Norman Lockyer has read to the British Association an interesting paper on the recent and coming solar eclipses; and Dr. Reynolds on certain electrical phenomena illustrative of the solar photosphere. Mr. Lockyer expressed a hope that the Association would lend its whole influence for the promotion of the most complete observation of the eclipse, and gave occasion to the President of the Association, Sir William Thomson, to follow on the same side. Sir William said that for the Association thus to act seemed to him to be a matter of the most vital importance. By means of the wonderful discoveries of Mr. Lockyer and M. Janssen, the phenomena of the solar atmosphere could at any time be investigated for a few thousand miles up, but during an eclipse the investigation could be carried from three to five times higher than at any other time. All civilised Governments should therefore unite, in order that observations of the coming eclipse might be made over a largely extended area. Their utmost exertions would not be too great for the utilization of the brief time afforded them, and he trusted that England would not suffer herself to be outdone upon such an occasion.

NEW PYROMETER.

A Pyrometer of great simplicity and of considerable accuracy has been invented by M. Lamy. M. Debray, following some researches of M. St. Claire Deville, has shown that what was called *Dissociation*, or breaking up of the combined elements, is as applicable to solid as it was found to be to gaseous compounds. Finding that carbonate of lime when heated in vacuo to 860° Centigrade decomposes itself, the disengaged carbonic acid having a tension of 85 mm.. and when heated to 1040° a pressure of 520 mm., M. Lamy has constructed a pyrometer by enclosing pure marble in a tube of porcelain,

attached to a glass tube containing mercury. When exposed to fire, dissociation takes place, and the temperature is indicated by the pressure; removed from the fire, the carbonic acid is again absorbed, and the instrument is again ready for use.—*Athenæum.*

OCEANIC CIRCULATION.

DR. CARPENTER has read to the British Association a paper "On the Thermo-Dynamics of the General Oceanic Circulation." The investigations in which he had been engaged with Dr. Wyville Thomson had furnished a new set of facts as regards deep-sea temperatures. It may now be asserted as probable that the bed of the ocean, below 2,000 fathoms, is everywhere, even under the equator, but little above 32° F. In the Channel, between Shetland and the Faroe Isles, it was found to be as low as 29°·5. In the Mediterranean, which has been tested at depths of 1,600 fathoms in its western, and 2,000 in its eastern basin, the temperature below the surface stratum of about 50 fathoms, heated by direct solar radiation, remains at 54° to the very bottom. This condition of things contrasts strongly with that which prevails in the eastern border of the Atlantic, under the same parallel. In the latter, as in the former, the superheating of the surface stratum by direct solar radiation shows its effects below the surface stratum. There is a very gradual fall from about 53° to 49°, which last is the temperature at 800 fathoms. But in the 200 fathoms below this, there is a rapid fall of 9°, and beneath this a further fall to 36° 5. The author regards this contrast as due to the Fact that the Mediterranean is virtually cut off from the great oceanic circulation. Dr. Carpenter attributes this circulation mainly to temperature, and attaches more importance to polar cold than to equatorial heat. As each surface film cools and sinks, its place will be supplied, not from below, but by a surface influx of the water around. The bottom stratum will, at the same time, flow away over the deepest parts of the basin. Sea water has no temperature of maximum density, but goes on contracting regularly to its freezing point, which is about 25°. As long as cold is applied to one part of the surface, and heat to another, there must be a continual movement below from the cold to the hot region, and above from the hot to the cold. That such a general movement really takes place is indicated, 1. By the prevalence of a temperature near 32° over the deepest parts of the great ocean basins. This could not be maintained on the warm sea-bed beneath, if there were not a continual flow of cold water from the polar area. 2. By the marked distinction between the upper and lower strata of the Atlantic, as regards temperature. 3. By the proved existence of a movement of warmer surface-water towards both polar areas. This is most observable in the North Polar area, on account of the contraction of its channel by the proximity of land. It shows itself in the warm current past Behring's Straits. In

view of all the facts, he was led to the hypothesis of a north-eastward movement of a vast stratum of oceanic waters, having a depth of at least 600 fathoms. In the remaining portion of the paper, the different causes of horizontal and vertical currents were discussed, and the opinion was expressed that the trade winds produce only horizontal motion.

THE PRESSURE OF THE ATMOSPHERE.

Professor A. Heller, of Ofen, gives in Poggendorff's *Annalen*, the description of an apparatus for determining the Pressure of the Atmosphere. The apparatus consists of a scale beam, to the ends of which are screwed two bodies nearly equal in weight but different in volume—a hollow sphere and a solid cylinder. On one end of the beam is a mirror which is approximately at right angles to the axis of the beam. At some distance from the apparatus is a telescope with a vertical scale, the image of which in the mirror is observed by means of a telescope. It is clear that when there is any change in the expansion of the air in the vicinity of the apparatus the beam will indicate varying angles with the horizon, which angles may easily be read off in the mirror by means of a telescope. The variations of the scale beam in consequence of alterations in the pressure will not amount to much if the dimensions of the apparatus are moderate; but the use of Poggendorff and Gauss' method of reading affords such a degree of accuracy that, as a brief calculation shows, under assumptions which are easily realised, the changes in the position of the beam can be measured with far greater certainty and accuracy than the height of the mercurial column in the ordinary barometer, provided the whole construction is light, and that its centre of gravity is at a short distance from the knife edge of the beam.—*The Engineer.*

GENERAL CIRCULATION AND DISTRIBUTION OF THE ATMOSPHERE.

Professor Everett has read to the British Association a paper "On the General Circulation and Distribution of the Atmosphere," the effect of the irregular distribution of land and water being left out of consideration, as constituting a separate subject of itself. The theory which he maintained is partly due to Professor James Thomson, and partly to Mr. W. Ferrel, of Boston, U.S. A body travelling along a great circle or a parallel of latitude, in the northern hemisphere, requires a constraining force from its right hand to prevent it from swerving to its right. This force is the same for all directions of motions in a great circle, and is (for a body of unit mass) twice the product of the linear velocity of the body relative to the earth's surface, the angular velocity of the earth, and the sine of the latitude; and when the motion is along a parallel of latitude, the force differs from this generally by less than one per cent. The falling off

of barometric pressure from the tropical belts to the poles and equator is due to the Fact that the movement of the atmosphere is, upon the whole, towards the east in extra-tropical, and towards the west in inter-tropical regions. The lower strata of air, having less than the average eastward or westward velocity which prevails in the strata above them, are not able to resist the differential pressure towards the pole or equator which the motion above them produces. This is the origin of the prevailing south-west winds in the north temperate zone. Similar principles apply to the southern hemisphere; but the tendency of a moving body there is to swerve to its *left*. The rotation of cyclones, the central depression in cyclones, and Buys-Ballot's law, are explained by this same tendency to lateral swerving.

ON THE ORIGIN OF LIFE ON THE EARTH.

THE opening address of the British Association, at Edinburgh, by Sir William Thomson, was remarkable for a new theory to account for the Origin of at least Vegetable Life upon the Earth. He objects to "spontaneous generation out of inorganic materials," but accounts for grass, and trees, and flowers, not by a creative fiat, but by fragments of solid seed-bearing matter, the *débris* produced by collisions between "great masses moving through space, and steered without intelligence." On this subject he said :—

"We must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instance no life existed upon this earth, one such stone falling upon it might, by what we blindly call *natural* causes, lead to its becoming covered with vegetation. I am fully conscious of the many scientific objections which may be urged against this hypothesis, but I believe them to be all answerable. I have already taxed your patience too severely to allow me to think of discussing any of them on the present occasion. This hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is, that it is not unscientific. From the earth stocked with such vegetation as it could receive meteorically, to the earth teeming with all the endless variety of plants and animals which now inhabit it, the step is prodigious; yet, according to the doctrine of continuity, most ably laid before the Association by a predecessor in this chair (Mr. Grove), all creatures now living on earth have proceeded by orderly evolution from some such origin. Darwin concludes his great work on *The Origin of Species* with the following words:—'It is interesting to contemplate an entangled bank clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so dif-

ferent from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us.'"

We are not aware that Sir William stated that even a single seed such as he speaks of was ever found in any one of the many meteoric masses which have been known to have fallen on the earth; but one may freely allow the possibility of innumerable seeds having so been scattered through space by cosmical collisions or explosions. All this, however, although it brings us the new idea of a sort of pleasant and neighbourly interchange of botanical and even of zoological specimens that may be going on throughout the planetary systems, sheds no new spark of light upon the origin of life in the abstract. We are still as far as ever from any idea of the possibility of life having had a beginning anywhere, either in the earth beneath, or in the heavens above, to which Sir William would refer us. Indeed, the question is thereby adjourned and removed altogether from beyond the field of human and terrestrial experience, to regions and conditions of which we know absolutely nothing. But the greater probability is, we think, that if ever life originated, it is quite as likely to have originated on this planet as anywhere else—the own life of the planet, we mean—animal, vegetable, yes, and mineral. And if the animal originated in the vegetable, quite as likely is it that the vegetable originated in the mineral; for the mineral creation has a life of its own, too, as any one will admit who ever studied the beautiful and often arborescent forms and growth of chemical combinations. No doubt it is easy to say—"Oh, but that is a different sort of life from vegetable life." No doubt of it; but so is vegetable life a different sort of life from animal life. There is a strong analogy, however, between *all three*; and that analogy centres in arborescence, as a kind of essential form or principle common to all these regions of nature.

The vine-like sprouting or arborescence of the blood-like bromide of iodine, in certain cases, over the sides of a vial, has all the look of just such a quintessential life-motor as one may readily suppose to be at work in the sprouting and arborescence even of blood-vessels, in the organism of the animal fœtus. We do not claim for it anything like identity; we merely say there is a strong analogy, even a similitude. And look to the curious sprouting into arborescent vegetable-looking forms, out of the *soil*, as it were, in a vial of chemical ingredients, such as bromine or iodine and antimony or arsenic, or iodine and tin, and a host of others, in sublimation, forced by "bottom heat" in a sand bath! The element, tellurium, sprouts, by heat of sublimation, into a beautiful fern-like structure, or *organism*, if we may so call it. Brom-iodide of mercury yields, by heat, arborescence with middle-ridged leaves! Note, too, our lead, silver, and other chemical trees. No doubt, simple chemical accretion has much to do with all this; but is there not accretion in the growth

of the more decidedly *organic* forms also, though of a more elaborate and exalted order? Once upon a time, the "growth of stones" was believed in by the vulgar and discredited by the learned; yet now it has been discovered by men of science not only that gold nuggets "grow," but how they grow! Solution of chloride of gold deposits gold upon gold, by simple accretion, and that is how nuggets grow.

In short, if the origin of animal life is based upon and issues from the principles of vegetable life, as Sir William Thomson and other men of science seem to hint, undoubtedly the origin of vegetable life is based upon and issues from the principles of mineral life; and there is plenty of that on the face of our earth itself without any necessity for being dependent upon other worlds for the germs of that vegetable life whence the life of animals is supposed to be *evolved.—Builder.*

Dr. C. Bastian has described to the British Association some new experiments he has made in relation to the Origin of Life, and said that the result of these led him to the conclusion that living matter might arise *de novo,* and that this living matter might go on to the development of certain common organic forms, just as surely as any speck of crystalline matter in a fluid might take on and assume certain definite characters which belonged to that saline substance in its crystalline condition. His experiments showed that living organisms had been found in fluids exposed to a temperature higher than was sufficient to destroy germs.

PHYSIOLOGICAL EXPERIMENTATION.

There has been read to the British Association the "Report of the Committee appointed to consider the subject of Physiological Experimentation," by Prof. Rolleston. 1. No experiment which can be performed under the influence of an anæsthetic ought to be done without it. 2. No painful experiment is justifiable for the mere purpose of illustrating a law or Fact already demonstrated: in other words, experimentation without the employment of anæsthetics is not a fitting exhibition for teaching purposes. 3. Whenever, for the investigation of new truths, it is necessary to make a painful experiment, every effort should be made to insure success, in order that the suffering inflicted may not be wasted. For this reason, no painful experiment ought to be performed by an unskilled person with insufficient instruments and assistance, or in places not suitable for the purpose, that is to say, anywhere, except in physiological and pathological laboratories, under proper regulations. 4. In the scientific preparation for veterinary practice, operations ought not to be performed upon living animals for the mere purpose of obtaining greater operative dexterity.

ACTION OF HEAT ON GERM LIFE.

DR. CRACE CALVERT'S recent investigations into the Action of Heat on Germ Life have disproved the theory that a heat of 212 Fahr. is sufficient to destroy all protoplasmic life. In several instances he found it maintained at 300 Fahr., while one small black vibrio not only resisted 500 Fahr., but all the chemical solutions brought to bear upon it. After this, experiments in spontaneous generation, which proceed upon the hypothesis that it is in the power of the operator to make sure of having excluded all living germs from his solutions, must be received with a good deal of caution.—*See next page.*

ORGANIC COMPOUNDS.

AT a meeting of the Academy of Sciences of Paris, M. Berthelot read a paper on "The Formation of Organic Compounds originating from Azotic Acid." According to his notion the explosive power of nitro-carbonatic compounds is the result of a kind of internal combustion analogous to that of gun-cotton. There is, however, a difference, because the elements of the azotic acid and those of the combustible principle are intimately united instead of being only mixed as it is in common gunpowder. This power is much greater, because the combustion developes more gas and heat, and the heat produced by the combustion is in excess of that created by the previous union of the azotic acid, owing to the organic principle having given less heat. M. Berthelot has measured the heat escaping from the formation of the most important derivatives of azote, such as azotic ether, nitro-glycerine, nitro-mannite, gun-cotton, azotic starch, nitrated benzine, biniter, chloroniter, nitro-benzoic acid, &c.

PETROLEUM.

COL. MACLEAN has read to the British Association a paper "On the Geographical Distribution of Petroleum and similar Substances." This paper embraced notices of the different forms in which these products are found—bitumen, petroleum, naphtha, and gas, &c., *mumia*, amber, and ambergris; notices of the places in which these various substances are found, the extent to which they have been known, and uses to which they have been applied since early times; bitumen of the Euphrates valley, the Dead Sea, &c., and the remarkable fountains of naphtha at Baku, on the Caspian; the application of petroleum, naphtha, &c.; their use for light, for medical purposes, for igneous missiles in war; virtues of the substance called *mumia*; the beliefs regarding the origin of this substance, of ambergris, and others of these products; concluding with a review of the geographical position in which they are found.

SPONTANEOUS GENERATION.

A PAPER has been read to the British Association "On Spontaneous Generation, or Protoplasmic Life," by Dr. Crace Calvert. The object of the inquiry was to ascertain if the germs existing or produced in a liquid in a state of fermentation or of putrefaction could be conveyed to a liquid susceptible of entering into these states. An essential point in the conduct of the investigation was the preparation of pure distilled water. By employing an apparatus through which a gas could be passed to displace the air, and adding to the water to be distilled a solution of potash and permanganate of potash, he obtained a water which, after three or four distillations, was found to be free from life. The gas employed in the first three series was hydrogen, and the water was kept in the apparatus till wanted, to prevent any contact with air. The water having been kept free from life for seventeen days, was introduced into twelve small holes, and left exposed to the atmosphere for fifteen hours, when the tubes were closed. Every eight days the tubes were examined. On the first and second examination no life was observed, but the third discovered two or three black vibrios in each field. A second series of experiments was made, placing the water in the tubes near putrid meat for two hours, at a temperature of 21° to 26° C. Six days after, some of the tubes were examined and life observed, showing that being placed near a source of protoplasmic life, the water had in two hours absorbed germs in sufficient quantity for life to become visible in one-fourth the time required in the first experiment. After six days a slight increase of life was noticed, but no further development could be afterwards seen. In a third series of experiments, albumen was added to the water. In this case life appeared in five days, and a considerable increase in ten. Albumen, therefore, facilitated the development of life. The quantity of life produced in the above experiments being comparatively small, some fresh water was distilled, oxygen being substituted for the hydrogen in the apparatus; and a fourth series of experiments resulted in showing that although oxygen appears to favour the development of germs, it does not favour their reproduction. When the weather had become much warmer, and a marked increase of life in the atmosphere had taken place, some of the albumen solution employed in the above experiments was left exposed in tubes to its influence, when a large quantity of life was rapidly developed, and continued to increase, proving the increase to be due not merely to reproduction, but to the introduction of fresh germs. As no life appeared in that portion of the distilled water remaining in the apparatus before mentioned, which was examined from time to time, whilst it appeared in all the solutions made with it, and impregnated by their exposure to the atmosphere, it is obvious that germs are necessary to the production of life.

IMAGINATION IN SCIENCE.

Dr. Tyndall has quoted some remarks made by Sir B. Brodie in support of his own peculiar doctrine concerning the use of the imagination in science. Sir B. Brodie adverts to the control of the imaginative faculty by physical observation and experiment; Dr. Tyndall, on the other hand, has not only advanced conjectures where observations and experiments have failed, but has advocated the free use of the speculative faculty for scientific purposes in fields beyond the present outposts of scientific inquiry. True, he would restrict the free use of the imagination to "privileged spirits" only. Should any Facts and observations be advanced against the conjectural conclusions, fancies, and imaginings of these spirits, they are to be overlooked, as proceeding from the wildness of the "weaker brethren," for, he goes on to argue, it is clear that beyond the present limits of observation may be all sorts of facts which, if they could be discovered, might be found opposed to the inferences to be deduced from the scientific facts we have. In this way not only is the correctness of the views of the class of privileged spirits proved, but the infallibility of the discoveries they are about to make is demonstrated long before the means of proceeding to be adopted to make the discoveries have been found out.—*Lionel S. Beale.*

SPECTRA OF HYDROCARBONS.

Prof. Swan has read to the British Association a paper on "The Wave Lengths of the Spectra of the Hydrocarbons." Prof. Swan stated that, in 1856, he had communicated to the Royal Society of Edinburgh a paper, published in Volume XXI. of their *Transactions*, entitled "On the Prismatic Spectra of the Flames of Compounds of Carbon and Hydrogen." In his observations on these substances he made use of an arrangement, employed by him still earlier, in 1846, identical with that which, since the publication of Kirchoff's and Bunsen's researches in spectrum analysis, is familiarly known as a spectroscope, namely, an observing telescope, a prism, and a collimator receiving the light to be examined through a narrow slit at its principal focus. The observations published in 1856 consist of carefully observed minimum deviations of fourteen dark lines of the sun spectrum, and of twelve bright lines of the hydrocarbon spectra, which bright lines were found to be identical in fifteen different hydrocarbons examined. No absolute coincidences between the lines in the solar and terrestrial spectra were observed, except that long before discovered by Fraunhofer, between the double sun line D and the double yellow line of ordinary flames, now, wherever or whenever it may appear, referred to sodium. The yellow line was generally present in the hydrocarbon spectra; but from a careful quantitative experiment it was ascertained that

the 2,500,000th part of a troy grain of sodium rendered its presence in a flame sensible; and the conclusion was then distinctly stated, it is believed for the first time, that whenever or wherever the double yellow line appears it is due to the presence of minute traces of sodium. In this state the observations of 1856 had remained until lately, when Mr. Swan was requested by his friend, Prof C. Piazzi Smyth, to compute the wave-lengths of some of the hydrocarbon lines. As no exact coincidence existed between these and the lines of the solar spectrum, it was necessary to have recourse to some process of interpolation, and that which suggested itself to Prof. Swan was founded upon Lagrange's well-known Interpolation Theorem. In order to verify as far as possible the results, the computation of the wave-lengths of the hydrocarbon lines was repeated by interpolating between different groups of sun lines, and the discrepancies between the numbers so obtained in no case extended beyond the place of units in Angström's scale of wave-lengths, where unity expresses the ten-millionth part of a millimètre.

A conversation then took place, in which Dr. Gladstone and Mr. G. J. Stoney took part, chiefly relating to Prof. Swan's discoveries in connection with the sodium line Prof. Swan said, Fraunhofer long ago discovered the coincidence of the double dark line D with the double yellow line of a sodium flame. What he himself claimed was this: in the hydrocarbon spectrum he found this yellow line coming and going in a manner which made him suspect it to be an intruder; and having found that the presence of an infinitesimal portion of sodium sufficed to render this line visible, he announced that, whenever and wherever this yellow line was found in a spectrum, it was due to the presence of sodium, and he believed he was the first person who ventured to make that announcement. This claim was allowed by those who took part in the conversation, and Dr. Gladstone went on to say that Brewster, at an early date, observed the coincidence between certain bright lines (those of potassium, for example), and dark lines in the solar spectrum; but it appeared to Brewster himself so strange that where the one spectrum gave light the other should give darkness, that they thought the less said about it the better, and some of their observations were accordingly not recorded.

HEALTH AND THE SPECTROSCOPE.

We learn from the *Quarterly Journal of Science* a most ingenious use of the Spectrum Analysis, which will doubtless suggest the usefulness of extending its application to the elucidation of many inquiries where it has heretofore not been appealed to. The case referred to is substantially as follows:— The water used by the inhabitants of a crowded court, amongst whom several cases of typhoid fever had appeared, was drawn from a rather shallow well, and was highly charged with various

unoxidised compounds of nitrogen. It was suspected that, from some defect, the contents of a public urinal obtained entrance to the well. The fact that the well-water contained seven times as much common salt as the normal water of the vicinity was some confirmation of the suspicion. Professor Church obtained absolute proof by the following method:—He introduced two grammes of a lithium salt into the urinal, and, two hours later, was enabled readily to detect with the spectroscope the presence of lithium in a litre of the well-water, which by previous examination had shown no trace of this substance.

THE SECOND GERMAN ARCTIC EXPEDITION.

A PAPER has been read to the British Association, giving an account of "The Second German Arctic Expedition," by Dr. Copeland, Astronomer to the Expedition. The object and aim of this expedition were the scientific examination and discovery of the Arctic central region contained within the 75th parallel of north latitude, taking the coast of East Greenland as a basis. Two problems were involved in this aim—(1) the solution of the so-called Polar question; (2) the discovery, survey, and examination of East Greenland, and those countries, islands, and seas connected with it and extending in a northerly direction towards Behring's Straits, a measurement of a meridional arc in East Greenland, excursions on the glaciers of the interior of continental Greenland, &c. Two ships were engaged in the expedition, and sailed from Bremerhaven on June 15, 1869, but after five weeks' sailing the vessels separated during a dense fog in lat. 75°. The *Germania*, Capt. Koldeway, proceeded northwards until its progress was stopped in lat. 75° 31′, or 23′ further north than Clavering and Sabine reached forty-six years before. At this point the land-ice lay quite fast, and extended fully ten miles in a north-east direction from the nearest land, while against its outer edge the enormous fields of pack-ice were so heavily pressed as to render progress impossible. Capt. Koldeway therefore determined to return to the Pendulum Islands, there to await in safety a change in the state of the ice. But the fact of the ship being frozen in did not discourage the members of the expedition, for not only were observations taken to ascertain the temperature and pressure of the atmosphere the direction and velocity of the wind, the amount of cloud, and the height of the tide from hour to hour, but excursions were also made, and geological, botanical, and ethnological specimens were obtained. During the spring the labours of the expedition mainly took the direction of a sledge journey to the north, under the leadership of the captain, when an advance was made of 150 miles in a straight line from the winter quarters, and at least one whole degree was added to our maps of the coast of East Greenland. Various other tours were made, which were rewarded by several

interesting discoveries, the most important being, perhaps, that of the musk-ox, which was found plentifully up to the 77th parallel. No recent traces, however, were found of the presence of the natives, but eleven skulls and many interesting weapons and utensils were discovered.

We have not space to give a detailed account of the work performed by the expedition, but ample and hearty testimony was borne to its merits by everyone who took part in the discussion on Dr. Copeland's paper. Dr. R. Brown, who is particularly well qualified to speak on the subject, spoke in the highest terms of the scientific results of the expedition, and of its additions to our knowledge of the distribution of plant and animal life in Greenland. The discovery of the musk-ox on the east coast of Greenland—hitherto not found south of Wolstenholme Sound, on the west coast—was remarkable; while that of the ermine and the lemming was equally interesting. The additions to our botanical and geological knowledge were also of deep importance. Physics had been attended to as well, and, taking it all in all, Dr. Brown declared that no expedition to the Arctic regions had ever surpassed this one in scientific importance—none during this century equalling it in the thoroughness with which *all* branches of science had been looked after by properly-trained special officers. On the motion of Col Yule, the members of the Section passed a resolution, expressing their admiration of the gallantry and resolution displayed by Capt. Koldeway and his colleagues, and their sense of the great value of the scientific observations and geographical discoveries which had been made.—*Athenæum.*

THE ROYAL SOCIETY.

On St. Andrew's day, the Royal Society held their anniversary meeting. More than usual interest attached to this meeting, as, in consequence of resigning the presidency, Sir Edward Sabine was to deliver his final address, and the society were called upon to elect a new President.

One of the leading topics of Sir Edward Sabine's address was the publication of the fifth volume of the great *Catalogue of Scientific Papers compiled by the Royal Society*, a work of which the importance can hardly be overrated. It contains the titles of all the scientific papers that could be collected from any part of the world published between 1799 and 1864, and will, we are informed, be completed next year with the sixth volume. The endowment of Kew Observatory with a sum of 10,000*l*. by Mr. J. P. Gassiot, F.R.S., was a topic on which Sir E. Sabine could dwell with satisfaction, considering the number of years during which he has taken a leading part in carrying on that establishment. The Royal Society are the trustees of Mr. Gassiot's fund, and the annual interest arising therefrom is to be applied for the maintenance and continuance of magnetical

and meteorological observations, with self-recording instruments, at Kew, and for investigations in physical science as may be required. Henceforward the Observatory at Kew will be one of the permanent scientific institutions of the country. The great Melbourne telescope (an instrument constructed by Grubb, of Dublin, under the supervision of a committee of the Royal Society, and paid for by the colony of Victoria) came next under notice, and with this favourable circumstance, that it was at first discredited in Melbourne, but that further experience has demonstrated the merits of the instrument, and the Government astronomer at Melbourne now reports that "its performance is highly satisfactory," and "that excellent work can be done with it." Important among the observations already made therewith is the fact that the nebula in Argo is undergoing rapid changes. From this the President passed to the equatorial telescope, constructed also by Grubb, at the cost of the Royal Society, for spectroscopic observation of celestial objects. This instrument has been placed in the hands of Mr. W. Huggins, F.R.S., who, at his own expense, has built an observatory to receive it, and is now devoting himself to the elucidation of some of the most interesting questions in physical astronomy. He has just ascertained that the spectrum of Encke's comet (then visible) showed the carbon line, agreeing in this particular with Comet II., 1868. The remaining topics were the series of pendulum observations made in India, and the untimely death of Captain Basevi, the observer; the confirmation, by the director of the Royal Netherlands Observatory at Batavia, of the existence of a lunar atmospheric tide; and the further exemplification by fossils brought from Greenland of the fact that the region within the Arctic circle had in ages long past a tropical climate.

The Copley medal awarded to Julius Robert Mayer, of Heilbronn, for his researches on the mechanics of heat, including essays on—1, the Forces of Inorganic Nature; 2, Organic Motion in connexion with Nutrition; 3, Fever; 4, Celestial Dynamics; 5, the Mechanical Equivalent of Heat—was then presented.

One of the Royal Medals was given to Dr. John Stenhouse, F.R.S., for his researches on the lichens and their proximate constituents and derivatives, including erythrite, and for his researches on the action of charcoal in purifying air; and the other to Mr. George Busk, F.R.S., President of the Royal College of Surgeons, for his researches in zoology, physiology, and comparative anatomy.

With the election of George Biddell, C.B., M.A., D.C.L., LL.D., Astronomer Royal, as President for the year ending Nov. 30, 1872, and the election of other officers for the year, the proceedings were brought to a close.

The anniversary dinner was held at Willis's Rooms, the new-elected President being in the chair. In the course of the evening the important services rendered to the society by Sir Edward Sabine during the eleven years of his presidency were recognised

with generous warmth, and with regret that by the increasing weight of years he should have been compelled to resign the distinguished place he has so long filled with advantage to the Society and to science.

TRANSPARENCY.

Professor Stokes has read to the British Association, a "Notice of the Researches of the late Rev. W. Vernon Harcourt on the Conditions of Transparency in Glass." Mr. Harcourt, who was one of the earliest and most active members of the British Association, carried on, for nearly forty years, experiments on the manufacture of glass for optical purposes. One of his most successful results was the construction of discs of terborate of lead and of a titanic glass, of about 3 inches diameter, almost homogeneous, and with which it is intended to attempt the construction of an actual object-glass which shall give images free from secondary colour. One of these discs was exhibited to the Section.

Mr. G. J. Stoney has given a paper "On a Cause of Transparency," the most interesting part of which consisted of an account of experiments on the spectrum of chloro-chromic acid. The positions of thirty-one lines in this spectrum were determined with an accuracy of $\frac{1}{500}$th of their mutual distances, and were found to be all of them harmonics of one fundamental vibration of too long period to be visible. These observations had suggested to him a theory of the cause of transparency in bodies, which he illustrated by reference to the jarring sound which is heard in the immediate neighbourhood of a bell when it is struck, but is not heard at a distance. The waves of light emitted by a radiating body are analogous to those sound-waves from the bell which travel to a distance, while the molecular motions of transparent bodies seem to resemble those confused motions of the bell which produce the jarring sound.

Mr. T. Stevenson, C.E., exhibited and explained "A New Reflector for Lighthouses"—A holophote was taken in which the paraboloidal portion consisted of facets of glass, ground to the proper curve, and silvered on the back. The same mode of construction was proposed for the new kind of apparatus—viz., a differential holophote, which, by means of a single agent, will collect with uniform density in azimuth the whole sphere of diverging rays into any one given cylindric sector. A mirror had been made of small plane facets, set optically in putty, but the difficulty of making one of continuous surface had been so great that Mr. Stevenson had consulted his friend Professor Tait, who had by quaternions solved the difficulty.

Professor Tait then gave the formulæ. Mr. J. R. Napier remarked that sea-going ships ought to be provided with more powerful lights than at present, and Mr. Stevenson's reflector appeared to be eminently suitable for this purpose.*

* Mr. Stevenson's *Lighthouse Illuminations on the Holyphotal System*, 2nd edit. just published.

Electrical Science.

THERMO-ELECTRICITY.

Prof. Tait has read to the British Association the following paper "On Thermo-Electricity." When one junction of a thermo-electric circuit is progressively raised in temperature, while the temperature of the other remains constant, the current increases more and more slowly, then decreases, and afterwards becomes reversed. Sir W. Thomson has explained this by regarding the actual current as the sum of two partial currents in opposite directions. The first partial current depends directly on the difference of temperature between the two junctions; the second depends on the fact that the source of electricity is not only at the junctions but all along the wires, two portions of the same metal at different temperatures behaving like two different metals. The experiments of Professor Tait consisted in observing the currents generated in two independent thermo-electric curcuits, with their hot junctions in one bath and their cold junctions in another, so that the temperature of the junctions were the same for both circuits. The following is Professor Tait's account of the results:—"Within the limits of temperature which have been imposed on me by the difficulty of getting wires of the more infusible metals, I have shown that the electro-motive force and the Peltier effect in a thermo-electric circuit are expressed in terms of temperature by parabolic formulæ. To carry the investigation further, and also more carefully to verify the parabolic form, I plotted the indications of one circuit in terms of those of another, both having the same temperatures of hot and cold junctions. It is obvious that this will give a very severe test, and, so far as I have yet gone, it is well borne out. By combining, by means of a differential galvanometer, the indications of two separate circuits at the same temperatures, and altering the resistance in one of them so as to make the separate parabolas *equal*, it is obvious that we get an arrangement in which the electro-motive force is proportional to the first power of the difference of temperatures."

Sir W. Thomson said it was curious to find how, about fifteen years after its discovery by Professor Cumming, the fact of reversal at high differences of temperature had now been confirmed with such definite laws of thermal action.

NEW WORK BY M. BECQUEREL.

M. Becquerel, sen., has laid on the table of the Academy of Sciences of Paris a work in MS., equal in amount to two ordi-

nary volumes, on the important subject of the intervention of physico-chemical forces in geological, meteorological, and physiological phenomena. The author demonstrates, amongst other things, the "celestial origin of atmospheric electricity, and the influence of electric action in the transformation of the blood in the body from venous to arterial." He explains, also by electric currents, an action which chemistry has been unable to account for, that is to say, the transport of materials within the organism, that is to say, life, for life resides in movement.—*Athenæum.*

CURATIVE ELECTRICITY.

MESSRS. BAILLIÈRE, Tindall, and Cox have thought fit at this moment to reissue the Rev. John Wesley's remarkable essay on "Electricity Made Plain and Useful." The publishers offer as their excuse the attention which curative electricity has lately aroused in the public mind. Many of Wesley's theories were considered, at the time, the fancies of an enthusiast, but modern experiments have shown that in his suggestions lay the germs of those splendid results of science which make "lightning itself our servant and messenger." The publishers have adhered to the great divine's quaint text. Not a word has been omitted or inserted; and the reader is left to judge for himself of Wesley's marvellous foreshadowing of the importance of electricity as a healing art in the present day.

ELECTRIC SIGNALS IN MINES.

IN Silesia and in Westphalia the use of Electric Signals in shafts is becoming very general; they are also very much employed in the basin of the Saar, where they are inseparable from mechanical hoists, &c. These electric apparatus have been applied, without modifications, to the *Graf-Beust* mines (Essen); their characteristic is that the voltaic circuit is closed by the earth. Along the circuit are interposed alarums and the manipulators, visible at every stage of the mine; the current is constantly closed; the alarums sound when the working of the manipulator interrupts the current; the pile is composed of twenty elements of brass-zinc plunged in a solution of sulphate of magnesia. At the mine of *Rhein Elbe* the system for the transmission of signals is quite different; they are transmitted from the bottom upwards, and *vice versâ.* In the transmission of signals from the bottom to the surface, a complete circuit is formed between these points. The manipulator is composed of a wooden fork, the teeth of which are covered in the interior with two sheets of copper in contact with the conducting wires; at the lower extremities of the sheets there are two metallic pendants which are brought into contact at the moment of interrupting the currents, by closing the teeth of the fork, when the passage of the current sounds the bells placed at the surface.

To transmit signals from the surface to the bottom, it is necessary, of course, to have a manipulator at the surface and bells at the bottom, but a single conductor only is required to be added, connecting the manipulator with the bells. The current is closed by the wire attached to the bells. The pile used at *Rhein Elbe* is composed of six elements zinc-charcoal plunged in a solution of mercuric sulphate, renewed every two months, for an extraction of from 400 to 450 tons per day. The wires are protected by a wooden sheath. The erection in a shaft 220 yards deep has cost nearly 40*l.*; in which sum are comprised the expense of materials required for a year and two spare elements. Each additional yard would cost about 3*s*, in a dry shaft the conducting wire can be covered simply with gutta-percha, in which case the expense would only come to about 24*l.*—*Mechanics' Magazine.*

THE FIRST IDEA OF THE TELEGRAPHIC DIAL.

In a work written by Father John Laurechon, a Jesuit, printed in 1624, at Pont-à-Mousson, under the title of "*Récréation Mathématique composée de plusieurs problèmes plaisants et facétieux*," there is to be found a curious passage, well deserving to be quoted:—"It is stated, that by means of a magnet, or any stone of the kind of loadstones, absent persons could communicate with each other, for example, Claudius being in Paris, and John in Rome, if each had a needle rubbed with some stone having the power, as one needle should move in Paris the other could move correspondingly at Rome; Claudius and John could have similar alphabets, and having arranged to communicate at a fixed time every day, when the needle had run three times and a half round the dial, this would be the signal that Cladius wished to speak to John and to no other. And supposing that Claudius wants to tell John that 'the King is at Paris,' he would move the needle to the letters *t*, *h*, *e*, and so on. The needle of John agreeing with that of Claudius would, of course, move and stop at the same letters, and by such means they could easily understand and correspond with each other. This is a fine invention, but I do not believe there is in the world a loadstone having such a power, and besides it would not be expedient, as then treason would be too frequent and too secret." Father Laurechon used to write under the assumed name of H. Van Etten. Annexed to the passage quoted, there is a diagram of a dial, with the 24 letters, having the needle fixed at the letter A. A similar allusion is to be found in the Dialogues of Galileo.—*Mechanics' Magazine.*

CONSTANT BATTERY.

L. Kohlfurst has devised an arrangement of a copper and zinc battery, which, he states, will, if used for ringing electric

bells, give a sufficient current for a year, at the cost of 1½ lb. of crystals of sulphate of copper. A truncated hollow cone of copper, closed at the top, forms the negative plate. This cone is thoroughly varnished inside, filled with crystals of sulphate of copper and placed mouth downwards in a glass cylinder deeper than itself. This cone has notches round the rim, and has a small hole in the centre of the top. The positive plate is a thick cake of zinc suspended over the face of the cone, cast with a hole in the centre, through which passes a gutta-percha covered wire, making the connection with the copper side of the battery. The glass cylinder is then filled with water, when it is evident that the rate of solution of the sulphate depends on the facility with which it is dissolved by the access of water through the notches in the cone, and this taking place at a uniform rate, the electric current arising from the mutual action of the copper and zinc in a solution of a given strength will be uniform also. The strength of the current is increased if, instead of water, a dilute solution of sulphate of magnesia, or of common salt, is used.—*Dingler Poly. Journal.*

HERRING'S IMPROVEMENTS IN TELEGRAPHY.

In the *Times* of January 30, 1871, is given a description of a telegraphic instrument invented by Mr Herring, and so constructed as to produce the dot and the dash of the Morse code in such a manner that one could never be mistaken for the other. This was effected by the use of two distinct levers, an arrangement which also permitted the dash to be made vertical instead of horizontal, and to be produced instantaneously instead of by continued pressure, thus saving the time of the operator, and diminishing the length of the message slip. The authorities of the Post Office took exception to Mr. Herring's first instrument, because it was intended to print. He then arranged it to emboss, and it was next objected to because it would not print. The latter objection seemed to be the one most likely to be insisted upon; and Mr. Herring has now removed it by completing a printing instrument of a very superior character.

In this instrument the slip of paper on which the message is received is made to travel by clockwork in the ordinary way. It passes directly over a thin metallic disc, placed transversely to the course of the slip; revolving on an axis, and dipping into an ink well over the paper, is a lever terminating in a broad style placed vertically above the disc, so that the descent of the lever compresses the slip of paper between the disc and the style. This lever is double, in the sense that its central portion, carrying the central portion of the style, can be acted upon either independently of the lateral portions, or together with them. In the former case only the narrow central portion of the style descends, and the slip of paper is pressed upon the inking disc at only a single point of contact, which produces a dot. In the

latter case the style descends as a whole, and, having a concave edge, it presses the paper into contact with the disc by more or less of this edge, thus producing a vertical dash. There is an adjusting screw, by which the inking disc may be raised or lowered at pleasure, and, by raising it, the length of the contact surface, and hence the length of the dash, may be increased at the pleasure of the operator. The pressure of the style stops for the moment the revolution of the inking disc, upon the immediate recommencement of which the ink supply depends. Mr. Herring has, therefore, placed upon the axle of the disc a box, containing a spiral spring so arranged that when the disc itself is checked the power of the clockwork coils the spring. The moment the disc is released the coiled spring gives the necessary impulse to produce immediate revolution.

The operator is furnished with two keys, one of which commands the central or dot portion of the lever, the other the lever as a whole. One, therefore, produces the dot, and the other the dash, and no mistake can occur between the two except by the use of the wrong key. The printing is remarkably clear, distinct, and compact, and gives a legibility to the messages which no other modification of the Morse system has at present attained. The instrument is worked with a double current, like that used for the double bell, with the great advantage over the latter that the signals are printed and permanently recorded, instead of being fleeting impressions upon the ear of the recipient.

Mr. Herring has also made some subsidiary improvements of importance, especially with regard to the relay, which promise to add to the usefulness of his instrument, but are of too technical a character to need description here. He also has it in view to work by means of a magneto-electric instead of a battery current, and to produce the revolution of the magnet by clockwork. At the same time he proposes to do away with the clockwork of the recording instrument, and thinks it will be possible to work forward the message slip by utilising the waste power of the lever by which the style is depressed

THE MORSE PRINTING TELEGRAPH.

PROFESSOR ZEUGER has read to the British Association, a paper "On a new Key for the Morse Printing Telegraph." He said :—

"I had the honour to show at the meeting of the British Association of 1868 a new automatical key to work the Morse printing telegraph. The key printed out three different signs—viz. a point, a short line, and a longer one. It consisted of three levers; by pressing them down steel springs moved along a very short or longer sheet of conducting material, and formed thus three signs of different length. Yet there was a certain time required to press down the lever, which by a spring was brought again to its former position. The telegraphist was

therefore bound to a certain speed in working the key, if the signs should be set off regularly. A clockwork arrangement moves a small wooden cylinder, whose steel axis is attached to it by a handle, and rotates with great velocity, being accurately indicated by a small bell sounding as often in a second as the cylinder will revolve in the same time. The wooden cylinder bears three thin circular brass discs, attached to the steel axis of the cylinder; these discs are differently cut out, in such a manner that the first is a full circle of 360 deg., the second a section of 110 deg. nearly, the rest of the circle being cut out and covered with wood to prevent metallic contact. The last bears only a segment of 10 deg., the rest being cut out and covered with insulating substances. Three levers put in front of the three discs bear on their end platinum plates that touch the discs during one revolution of the cylinder when pressed down. From every lever there is a conducting wire led to the printing apparatus; and the lever is reduced to its former position by a strong steel spring, so that it regains rapidly its position after the pressure of the finger has ceased. Whatever be the speed of the paper and the clockwork moving it, the relative length remains unalterably the same. In this model the motion endures for 15 minutes, and, being only a model, it has no rollers for the paper sheet. In the working instrument the printing apparatus with its rollers is attached to the key, forming only one apparatus together. From that contrivance results a quite equal distance of the single signs as in printing, and by putting the fans of the clockwork in differently inclined positions the rapidity of motion may be carried as far as a clever telegraphist can manage it. By using three signs, the combination to 1, 2, and 3 gives 39 signs. This will do for all letters, figures, and phrases commonly used, and spare nearly 30 per cent. of space, and therefore of time, enabling an able telegraphist to give 30 to 38 words by the middle speed of the clockwork."

The Professor illustrated his paper by a model of the machine.

BARTON'S PATENT RECORDING TELEGRAPH.

This consists of two plain revolving dials, each having a double groove at the rim to admit of an endless cord or rope, also a handle and a finger or indicator; and these are connected by an endless band of steel wire rope or any other fitting material. Upon this endless band or rope are fixed hanging swivels or holders, into which any kind of message written on ordinary paper or any other material, or a sealed missive if necessary, is inserted. This done, the sender, A, simply turns the revolving dial until a small bell above the same gives the alarm, which by doing so announces that A's message has reached the receiver, B. Should B at the other end wish to send an answer back to A, he proceeds in the same way as A did at starting, the arrival of B's message to A being similarly

announced by the ringing of a bell. If preferred, the messages can be sent from one department or office to another through tubes. If not thought desirable to send written messages, numerals or letters of the alphabet can be used instead, each numeral or letter of the alphabet representing some pre-arranged order or message for the day. If preferred, previously prepared messages—before the duties of the day commence—can be slipped in spaces around the dials instead of using numerals or alphabetical signs. Other applications of a similar apparatus are suggested.—*The Builder*.

PROTECTING TELEGRAPHS FROM LIGHTNING.

MUCH trouble has always been experienced from lightning on a section of telegraph line between Riverside and the Stock Yards, on the Chicago, Burlington, and Quincy Railroad. Poles are frequently shivered to splinters, and much other damage done during the heavy storms which occur there during the summer. About a year and a half ago, Mr. F. H. Tubbs tried the experiment of attaching a lightning conductor to each pole of this section, consisting simply of a No. 7 iron wire, one end of which was secured underneath the iron ring at the top of the pole, and the other buried in the ground, the wire making one complete turn around the pole two or three feet below the top. This simple and inexpensive precaution has thus prevented any damage whatever from lightning on the section protected, although this is the second summer it has been in use, while formerly not a summer passed without several poles being destroyed in this manner.—*The Telegrapher*.

ELECTRICAL ANEMOMETER.

A NEW form of Anemometer, the invention of Mr. J. E. H. Gordon, has just been constructed by Mr. Apps, and seems likely to prove of material service to all who desire to notice and record the direction and velocity of the wind. As now made, the anemometer consists of an ordinary pair of Beckley fans and a set of revolving cups, fixed in any convenient situation, and connected by insulated wires with a galvanic battery and with a recording apparatus. There is no limit to the length of the connecting wires, so that, for example, recording instruments at Lloyd's might be connected with fans or cups at any part of the coast. The recording instrument itself consists of a clock, a wind dial, a reel of paper, and an endless band carrying a carbon paste for printing. The dial indicates the direction of the wind, and the printing band prints this direction every half-hour. The same band records every quarter of an hour of time and every completed mile that the wind has traversed. The slip of paper issued by the machine is about an inch broad, and it receives the time on its left-hand margin, the direction of the wind on its right-hand margin, and a

dot for each mile on a central line, so arranged as to be comparable with the time record. The number of dots marked on the paper between 10 and 11, for example, indicate the velocity of the wind during that period of time, and the dots become crowded as the velocity increases, and stand farther apart as it decreases. The battery is composed of zinc and carbon elements with dilute sulphuric acid, and will work for six months without attention. The reel of recording paper holds a supply for three months, and the clock can be made to run this length of time without winding; so that the whole apparatus would be as nearly as possible self-acting. Ordinarily, however, it would be desirable for the attendant in charge of it to date the recording slip every twenty-four hours, and an eight-day clock would be sufficient for the requirements of most observers. The great advantage of the instrument is in the character of its records, and in the fact that the electrical communication does away with the use of cranks and shafting, which are not only costly and heavy and far less delicate, but which also render it necessary that the recording instrument should be in the immediate neighbourhood ot the fans.—*Times*.

PROCESS FOR NICKEL-PLATING.

Professor F. Stolba communicates a plan for Nickel-plating, by the action of zinc upon salts of nickel, in the presence of chloride of zinc and the metal to be coated. By this process, the author states that he has succeeded in plating objects of wrought and cast iron, steel, copper, brass, zinc and lead. It is only necessary that the size of the objects should permit them to be covered entirely by the plating liquid, and that their surfaces should be free from rust or grease. The following is the *modus operandi*: A quantity of concentrated chloride of zinc solution is placed in a cleaned metallic vessel, and to this is added an equal volume of water. This is heated to boiling, and hydrochloric acid is added, drop by drop, until the precipitate which had formed on adding water had disappeared. A small quantity of zinc powder is now added, which produces a zinc coating on the metal as far as the liquid extends. Enough of the nickel salt (the chloride or sulphate answer equally well) is now introduced to colour the liquid distinctly green; the objects to be plated are placed in it, together with some zinc clippings, and the liquid is brought to boiling. The nickel is precipitated in the course of fifteen minutes, and the objects will be found to be completely coated. The coating varies in lustre with the character of the metallic surface; where this is polished the plating is likewise lustrous, and *vice versâ*. Salt of cobalt affords a cobalt plating, which is steel grey in colour, less lustrous, and more liable to tarnish than the nickel.—*Dingl. Polyt. Jour.*

THE ELECTRIC LIGHT.

M. V. SERRIN has introduced an arrangement of the Electric Light fixed in the focus of a parabolic mirror of silvered copper, by means of which a strong beam of light can be thrown in parallel lines upon any point of an enemy's fortifications. A very ingenious arrangement keeps the charcoal points at always the same distance, thus securing the constancy of the light.

THE INDO-EUROPEAN TELEGRAPH.

THE *Times* of April 10 records the most striking triumph of modern science. The Indo-European telegraphic line now works directly with England without any re-transmission. On the 8th communication was established between London and Kurrachee, and the first message was sent from India to England instantaneously by the director at Kurrachee. A commercial message was forwarded direct to Kurrachee for Calcutta, and the line was put direct through to Bombay; Bombay and London, 6,000 miles apart, then exchanged signals; and at 1.58 a commercial message was sent to Bombay and instantaneously acknowledged.

IMPROVEMENTS AT THE TELEGRAPH OFFICE.

MR. SCUDAMORE has explained at the Central Telegraph Office some novel mechanical arrangements for the transmission of messages from one floor to another, and from one to another part of the same floor In the ordinary business of the office it is necessary that "messages," that is to say, the sheets of paper on which messages are written, should pass through the hands of a succession of clerks prior to being issued for delivery. Until lately this requirement has been met by "lifts" from floor to floor, and by the employment of boys as messengers between the different check-tables on the same floor The lifts were worked by hand, and the boys, threading their way in and out among the closely set tables on which instruments are placed, were a source of trouble and distraction to the clerks engaged in sending or receiving messages, and disturbed the general order and discipline of the rooms. These disadvantages have now been obviated by connecting the check tables and the different floors by endless bands, kept in motion by the steam engine that is used to exhaust the pneumatic carrying tubes. The bands are of tape or thin webbing, running over small wheels at each extremity of their course, as well as at every angle that they turn; and four bands are used for each track of what may be called a message tramway. The principle of their action is familiar to mechanicians, and is employed for many purposes, notably for feeding some forms of printing press; but its present application is extremely pleasing and ingenious. Between tables in the same room the course of the messages may be traced. The tapes at

first rise vertically to a sufficient height to be clear of the traffic below, then cross the room horizontally, and descend on arriving over their destination. A message slipped between the wheels at one side is instantly carried away and rapidly delivered at the other. From floor to floor the bands pass down shafts, or through covered ways; and at every terminus there is a lever by which any set can be stopped without disturbing the rest. But unless put out of gear they are always running, and thus the indoor messengers previously employed can be almost entirely dispensed with, to the great gratification alike of clerks and overlookers. In fact, the new arrangement gives so much satisfaction, and now that it is at work seems so obviously the right one, that it excites marvel how it could so long have been done without. The total number of messages sent over the postal system during the three months ending on the 1st of July was 2.803,798, against 2,326,639 for the same period of last year, and the revenue for the same periods 163,636*l*., against 135,788*l*, an increase of 477,159 messages, and of 27,848*l*. of receipts, in favour of the quarter just ended. This is altogether irrespective of the revenue derived from the rental of special and private wires, and from the news' service of the whole country.—*Times*.

MILITARY ELECTRIC TELEGRAPHS.

The *Mechanics' Magazine*, discussing the employment of electric telegraphy for military purposes, mentions one important attribute of piles made with bichromate of potash. "These piles can also be applied to the service of surgeries, to cauterise wounds, and for effective ablations to the incandescent thread. Some late experiments have proved that electric cauteries resolve at once the burn at the first degree of the attacked organ, and consequently annihilate sensibility instantaneously, so that no pain remains after the operation. Thus the pile with bichromate of potash is available both as an engine of war, or of relief and aid in surgical operations."

SIR WILLIAM THOMSON'S SYPHON RECORDER

At the late Converzatione of the Institution of Civil Engineers, was exhibited the Syphon Recorder of Sir William Thomson, being the greatest telegraphic novelty, consisting of a very powerful electro-magnet, between the poles of which is suspended a core wound with fine silk-covered copper wire. This wire is put in the circuit of the telegraph line, through which the signals are received. The reading of the signals is effected by means of a syphon of capillary glass tube, about 2 in. long, the shorter end of which dips into a dish of ink, while the larger hangs down, in front of a paper strip moved forward by clockwork. The miniature glass syphon is connected by a very fine aluminium wire, with the coil suspended between the poles

of the electro-magnet, and is moved backwards and forwards as it is deflected to the right or the left. The way in which the ink is got through the capillary tube, and not only got through it, but actually ejected in a tiny stream from the lower end of the syphon, is by the simple and ingenious expedient of keeping the ink electrified to a high tension. When any liquid is electrified, its particles repelling each other, it is enabled to flow through the finest orifice; and this fact has enabled Sir William Thomson to produce a frictionless pen-point. The electrification of the ink in the reservoir is done by a rotating electrophorus or replenisher, kept in movement by an electro-magnetic machine.

WHEATSTONE'S AUTOMATIC INSTRUMENTS.

MR. CULLEY, the Engineer-in-Chief of the Telegraphic System of the United Kingdom, says:—

"In order to increase the number of messages which could be sent through the wires in a given time, a very large use has been made of the Wheatstone Automatic Instruments. This system was in use by the Electric Company before the transfer. There were four circuits then; since the transfer 15 circuits have been supplied with this apparatus. In addition to these automatic circuits for ordinary business, we have fitted up what we call the Western News circuit for automatic work. This circuit runs from London to Bristol, Gloucester, Cardiff, Newport, Exeter, and Plymouth. The news is sent to all these places simultaneously, and at the rate of 50 to 55 words a minute. We have also done a great deal in the way of pneumatic communication in towns. Much has been done in the improvement of the line wires, which came into the possession of the department so badly insulated that whenever it rained communication was stopped. Had not the public put so severe a pressure upon the department for extension to new places—such a pressure as it was impossible to resist—I think I might have been able to secure more efficient work and a better service. We have effected a very great improvement, at considerable expense, in the single needle instrument. The department has had a very large number of inventions brought before it, and it might have been hoped that very considerable advantage to the public might have arisen from the breaking up of the monopoly of the companies and the private interests which almost all the officers had in perpetuating the form of some old instrument. But I am sorry to have to report that not in any one instance has any apparatus or system of signalling been laid before me of practical value. One system only has been of such a nature as could possibly have any value, and that would require fully ten years to mature before it could be brought out. I think it right to say this much because it was supposed that a number of useful inventions had been kept back because of the indisposition of the companies to use them."

WHEATSTONE'S AUTOMATIC TELEGRAPH.

PROFESSOR WHEATSTONE'S automatic or fast-speed telegraph consists of three parts—the perforator, the transmitter, and the receptor. The perforator consists of an iron case with three keys, which are struck down by the operator. These keys work three punches which produce holes corresponding to dots, dashes, and spaces in the paper strip. The transmitter consists of a clockwork which draws the prepared paper forward with a continuous motion by the teeth upon the periphery of a spur-wheel entering the central line of holes of the paper The holes on the one side or the other represent the positions of positive or negative currents. There are two small vertical pins which move up and down underneath the paper strip, one under one row of holes, the other under the other row. When a hole occurs, the pin rises through it, and allows the lever to which it is fixed to oscillate far enough to make suitable contact with the battery. When, however, no hole occurs, the pin is stopped against the paper and no contact is given. The receptor is somewhat similar to an ordinary ink-recording Morse apparatus. It is somewhat finer in the arrangement of its parts, and the various moving portions are made studiously as light as possible, a principle upon which, there is no doubt, the great success of sensibility and fast working depends. The entire apparatus is a highly ingenious and meritorious production.

SIEMENS'S AUTOMATIC WRITER

THE principal difference between this writer, puncher, and sender and that of Wheatstone's automatic telegraph is that in Siemens's the paper strip is provided with a continuous line of holes previously to its being punched with the holes for giving the currents; and in the current-holes being provided in the requisite groups by punchers worked by a key-board, so that the operator has only to press one key for each letter, instead of composing the letters of the elementary signals. This apparatus consists of a piano key-board, with as many keys as there are letters, figures, and marks of punctuation. It is so adjusted that the momentary touch of a key suffices to completely punch the required signal, letter, or cipher, and to advance the paper exactly so far as to place it in the proper position for the next signal. Practised workers can in this way prepare, for mechanical or automatic sending, from three to four letters or other signals per second. The transmitter used with this system is arranged either for magneto-electric, or for galvanic currents. For the latter the contacts with the alternate holes are given by means of a special commutator made in the form of a roller or drum cut in halves, which come together in saw-teeth, and fit into one another without touching. These halves are connected with the two poles of the battery, and as the holes in the paper strip occur at intervals corresponding to

the breadth of the teeth, the contact spring or brush falling through a hole makes contacts with the alternate holes as the grouping of the signal requires. The receiving apparatus is a very delicate ink-writer, the cores of its electro-magnets being made of rolls of sheet iron.

LORD LINDSAY'S MAGNETIC EXPERIMENTS.—VARLEY'S VACUUM TUBES.

At the recent Conversazione of the Institute of Civil Engineers Lord Lindsay exhibited a very powerful magnet, and himself conducted some experiments with it and some vacuum tubes. These experiments, which were both magnetic and dia-magnetic, were very interesting. The poles of the magnet were 2½ in. square in section, and the magnet was excited by a 30-cell groove battery. The poles were kept 3-16ths of an inch apart and a half-crown piece was placed between them. When the magnet was not excited the coin dropped instantly through, but when the magnet was charged the half-crown was six seconds in falling the distance of 2½ in. In a second experiment a small india-rubber tube filled with mercury was placed between the poles, and an electric current passed from the battery through the mercury. Directly the magnet was excited the tube was set in motion, getting away from between the poles and assuming the shape of the letter S. Upon reversing the current the shape of the curve was instantly reversed. After this a coil of copper wire was placed round the vertical pole of the magnet, and when the magnet was charged, and a current of electricity sent through the copper coils in one direction, the ring of fine copper wire stuck fast to the magnet. On reversing the electric current the ring jumped off the pole of the magnet some distance into the air. In order to show the dia-magnetic properties of warm air, a lighted taper was passed through a hole bored along the poles of the magnet, the light being brought to the space of ⅛ in. wide, between the two poles. So long as the magnet was excited the light burnt brilliantly, the smoke coming out at the extreme ends of the poles, and not rising up directly off the flame. As soon, however, as the magnet was discharged the smoke rose straight up and extinguished the flame.

Experiments were next made with some vacuum tubes exhibited by Mr Cromwell Varley, to show that the luminous arch was dependent wholly upon the magnetism, and was independent of the direction of the electric current. The discovery of this arch is due to Plucker, and it has been examined by Mr. Varley and found to consist of very attenuated matter, thrown off from the negative pole. This was demonstrated in the following manner:—A strip of talc, 1-10th of an inch broad and 1 in. long, weighing 1-10th of a grain, was suspended in the exhausted tube by means of a single fibre of raw silk. When the luminous arch was allowed to play against this piece of talc it repelled it,

and although the silk did not burn, yet the glass tube was made hot. From this circumstance Mr. Varley infers that the electric current passing into the negative pole detaches small particles of matter from it. These particles are thrown off with tremendous rapidity, and are controlled in their course by the magnetic rays forming the luminous arch, the heat in the glass being produced by the concussion of these particles against the solid body. Lord Lindsay, who is largely engaged in physical experiments, is having a monster magnet constructed, which, when completed, will, it is said, be the largest in the world.

ACTION OF MAGNETISM ON GAS TRAVERSED BY AN ELECTRIC CURRENT.

On this subject Messrs. A. De la Rive and E. Sarasin have presented to the Society of Physics and Natural History of Ginevra, a very important communication, of which we quote the conclusions :—

1. The action of magnetism, when only exercised upon a part of an electric jet projected through a rarefied gas, causes an increase of density.

2. This same action, when exercised upon an electric jet placed equatorially between the poles of an electro-magnet, produces, in the rarefied gas, in which the jet is propagated, an increase of resistance, so much the more considerable in proportion to the conductivity of the gas itself.

3. This same action creates, on the contrary, a decrease of resistance when the jet is directed in the line of the axis between the two magnetic poles; such decrease being also greater in proportion as the gas is a good conductor.

4. When the magnetic action consists in the impression of a continued movement of rotation of the electric jet, this action has no influence upon the resistance, if the rotation is operated on a plane perpendicular to the axis of the cylinder of magnetised iron, which determines the rotation; whereas the resistance decreases considerably if the rotation takes place in such a manner that the electric jet describes a cylinder of revolution about the axis.

5. These several effects cannot be attributed to variations of density produced by the action of magnetism on the gas, but probably they are to be explained by the perturbations that such action creates in the molecular arrangement and disposition of the particles of the rarefied gas, necessary for the propagation of electricity.

MAGNETIC-MOTIVE POWER.

The idea of substituting magnetism for steam has long been discouraged by electric writers as visionary and impracticable. They have asserted the impossibility of any such economic use as the material for the production of magnetic power as could

ever justify the hope of its substitution for steam. They were right so long as the battery was regarded as the source of power instead of a mere initiative, such as results now seem to prove it to be. Our theories of electro-motive force may require to be re-examined, and perhaps changed. The axiom that a given magnetic force is the exact product of a given consumption of zinc or chemicals must now be challenged, and put to the proof. We confront now the proposition that, although the electro-motive force may be in the battery, yet that the magnetic power which follows its application is capable of indefinite enlargement without increase of the initiative agents. We are brought face to face also with the Fact that, when a magnet is performing its maximum work, the battery which started the magnetic power is most at rest. In other words, that the magnetic power is not proportioned to the size or consumption of the elements of a battery, although dependent upon it as an initial force. We do not pretend to explain this problem, but we can tell what we have seen. It seems to corroborate the recent position taken by Mr. Highton, of England, and to prove that we are on the borderland of a new and wonderful series of developments of an economic, safe, and efficient motive power. It may prove that our assumed data as to the power resident in our battery materially has been underrated, and their productivity misunderstood.

We now state what we have seen. We accompanied, on invitation, several gentlemen to the works of Mr. H. M. Payne, of Newark, N.Y. [A description of a powerful magnetic saw-mill which the editor saw in action is here given.] This rapid and effective action has been watched nine consecutive hours by investigating parties, without any perceptible decline of power, and with a consumption of less than half-a-pound of zinc—a cost of less than half-a-cent an hour. The power developed was rated at two-horse, and can be maintained for twenty-four hours without intermission at a maximum cost of ten cents. Such, at least, is the statement made to us by Mr. Payne, and confirmed by a well-known gentleman, who thoroughly examined it. By increase of diameter and width, or by multiplication of wheels, and the number of magnets, the power can be largely increased, so we are assured, by the same number of cells. This was proved by the fact that by the addition of wire in the circuit of sufficient length to surround another set of magnets, no diminution of power was apparent, although the action of the battery was necessarily less; thus another wheel of similar power could have been added. The four cells we saw were stated as capable of maintaining the speed and power produced in our presence for sixty hours without renewal, at the cost of about a single stage fare on Broadway per day. In this machine, so utterly simple as to challenge the scrutiny of the most ordinary mind, we see the dawn of a new power, capable of endless application at a minimum cost, and destitute of the usual element of danger. It occurs to us as very strange that what is just being proposed

as a possible status of facts by a learned divine in England should prove the self-same theory which an American citizen has been privately and persistently developing in actual practice for years. To what it may give rise, we have no prophet's ken to tell. If the premisses demanded are proved to be correct, its application is infinite. We may yet see the Atlantic crossed by huge vessels, propelled without an ounce of coal, by a power the initiative of which the captain may place beside his writing desk in his cabin, which a child can apply, and the littlest finger may stop. The begrimed furnace-man may then come out from these lower hells, and walk the deck as clean as the passenger, and the blazing fires be put out. And it may be in the mysterious workings of the Almighty, that these electric forces, which are on every hand developing themselves as the life of the world. quickening its pulses from pole to pole, the cause of growth, and the cardinal element of a power the limit of which is yet unknown, may be ordained to remove from man part of the curse of toil, unbending the labourer's back, and making him to stand erect as at the first.—*New York Telegraph Journal.*

NEW ELECTROMETER

Sir William Thomson has brought out an Electrometer, which has now assumed a very complete form. His divided-ring electrometer admitted of accurate measurements, in skilled hands, of fractions of a Daniell's cell, his portable electrometer admits of readings from 10 or 20 cells upwards; but his new reflecting electrometer gives as much as 100 divisions on the scale for one single cell of the battery. In Mr. Varley's patent of 1860, he describes a method which he employed to make the one plate charge itself, and on this principle he constructed a large electrical machine, which he exhibited at a soirée of the Royal Society of 1869–70. This machine has been adopted by Sir William Thomson for maintaining the charge in his electrometer. This new electrometer is really a combination of three inventions—of Sir William Thomson's portable electrometer to indicate whether or no the instrument is sufficiently charged, of the replenisher by Mr Varley for charging or discharging; and of the quadrant electrometer for reading off the minute tensions measured. This instrument is in its present form so practically useful that it has been largely used in connection with telegraphic cables, and Mr. Varley has calculated tables to enable any electrician at a glance to infer from two readings by this electrometer the insulating power of any telegraphic cable.—*Mechanics' Magazine.*

Chemical Science.

THE EXPLOSION OF GUN-COTTON AT STOWMARKET.

THE terrible disaster at Stowmarket, on the 15th of August last, when some fifteen tons of compressed gun-cotton exploded with fearful violence, sweeping away the works and buildings of the Patent Safety Gun-cotton Company, has already been detailed at pp. 64–66. The inquest which followed had the character of an exhaustive inquiry, and resulted in a verdict that the gun-cotton at Stowmarket had been tampered with wilfully, and that it was in an impure state, and therefore liable at the time of the explosion to spontaneous combustion. Meanwhile, the War Office authorities deemed it advisable to damp the store of gun-cotton at Upnor Castle, and thus avoid all risk, gun-cotton in the damp state being uninflammable.

In September the Secretary of State for War appointed a special committee, consisting of officers and gentlemen, to report upon certain points relative to the employment and manufacture of gun-cotton.

The several points which the committee were required to investigate were:—

1, Whether the employment of gun-cotton is attended with such uncertainty or peril as should induce the War Department to relinquish its manufacture and its use for those military purposes for which it has hitherto been considered peculiarly valuable, 2, whether its manufacture in all its various stages is a dangerous process, and one that should not be carried on near an inhabited neighbourhood, and whether additional precautions to those now in force seem necessary; 3, whether the storage of gun-cotton, either wet or dry, is necessarily attended with danger in magazines on shore, or on board ship under any or all conditions of temperature; 4, whether, either in a pure or impure state, it is liable to spontaneous combustion, and, if so, whether such combustion would result in explosion or in mere ignition 5, the nature of buildings best suited for the storage of gun cotton.

The committee were further directed to report upon any other points which might arise in the course of their investigations, and to which they might desire to draw attention. The committee also made themselves acquainted with all the official reports that have been furnished on the practical application of gun-cotton especially the report of the Royal Engineer Committee of 1870 which treats of an extensive series of experiments with gun cotton in military mining, demolitions, and submarine mining After a careful review of the documents in their possession, and of the evidence of the above-named officers respecting the use and application of compressed gun-cotton, principally as regards

its employment for military purposes, the committee have come to the conclusion that its use is not only unattended by either uncertainty or peril, but that the material as an explosive agent is effective, certain, safe, portable, and easy in employment. They feel warranted, therefore, in the expression of a strong opinion of its great value for military engineering purposes generally, as well as for submarine mining. Compressed gun-cotton is a material of comparatively recent development. It is only within the last three or four years that Mr. Abel has perfected his process of manufacture, and the evidence respecting the stability of a material which has been in practical use for little over two years is necessarily meagre, time forming an essential element in determining upon this important quality. As bearing upon this point, the committee refer to the opinions of the officers they examined, to the effect that, during the limits of twelve separate months, no change has been observed in the store at Chatham. They further state that considerable quantities of compressed gun-cotton have been sent during the past two or three years to hot and damp climates, and have undergone voyages to Australia and India without, so far as they could learn, any accident whatever.

The Stowmarket Company are said to have supplied a quantity in 1870 for India, the gun-cotton being at first stored in a floating magazine on the Thames, and subsequently at Calcutta A recent report states that this supply shows no indication of any change. Reports from Austria are also said to be satisfactory respecting the stability of gun-cotton. These and the elaborate investigations made and published by Mr. Abel have satisfied the committee that no hesitation need be felt in continuing the employment of compressed gun-cotton through any fear of undiscovered unstable qualities. This opinion is also justified by the condition of the gun-cotton for several years stored in magazines at Woolwich. Some of these specimens have been purposely left impure under varying conditions of exposure to light, heat, and change of temperature. Their present unaltered state is regarded by the committee as affording fully confirmatory testimony that, under at least all ordinary circumstances, gun-cotton may be regarded as a staple material. They also observe that the experiments on stability of gun-cotton, extending over a long period, refer to the material in the form of rope or skeins, that is gun-cotton in a loose state, as distinguished from the substance compressed into blocks, or discs. from pulp on Mr. Abel's system It has, however, been satisfactorily proved that gun-cotton produced from the long-staple cotton cannot be so perfectly purified as pulped gun-cotton; it follows that all the evidence in favour of the stability of gun-cotton in the loose state applies with much greater force to compressed gun-cotton, in the purification of which the pulping process has been applied.

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made themselves acquainted with the nature of the several processes constituting Mr. Abel's system up to the stage in which gun-cotton is compressed into discs and ready for use. They find that in all these processes the material, from the moment of its conversion into gun-cotton, and up to the drying stage, is in a wet state, and at the final stage of leaving the press contains from 15 to 20 per cent. of water. It is thus throughout every stage perfectly uninflammable, and the committee express themselves satisfied that no danger can possibly result from its manufacture (with the exception of drying) in any locality, whether in or near a town. As regards the drying, the committee are of opinion that the operation as followed at Stowmarket is open to some objection. They do not attempt to discuss these objections in the present report, but remark that they apprehend no difficulty in devising a safe and simple method, which may be easily applicable to any locality. Lastly, the committee record their opinion that there is no reason why the War Department should relinquish the manufacture of compressed gun-cotton.

The recommendations have, we understand, been approved, and there now appears to be no difficulty in pushing on the Gun Cotton Works at Waltham Abbey, where only the wet process will, at present, be followed.

In spite of the Stowmarket explosion, we think there is every reason to look forward to a great triumph for compressed gun-cotton as a mining agent, both military and civil; but we have no wish that this article should claim any monopoly; nay, we should be glad to see a rival in the field, were it only to promote greater vigilance and care in manufacture. If dynamite or lithofracteur can compete with compressed gun-cotton in cost, lightness, the security with which it may be handled, the rapidity with which it may be applied, the safety with which it may be manufactured, transported, and stored, and the explosive power it is capable of exerting, well and good.—*Abridged from the Times.*

GUN-COTTON—ITS ORIGIN AND PROPERTIES.

A HIGHLY interesting paper by Professor Abel, upon the Origin and Properties of Gun-cotton, published in the *Chemical News*, should afford cheering and positive assurances that this substance is really trustworthy and stable, in spite of recent experience. The Professor says: It is safe when wet; it is safe, if only pure, when being dried upon hot plates; closed boxes of the compressed explosive only burn mildly when fired by flame, and "go off" quite genteelly and without fuss, even when a Martini bullet is discharged into them at close range. "Numerous other proofs," the article declares, "have been obtained of the safety of compressed gun-cotton compared with gunpowder." This seems thoroughly satisfactory; and we turn our gaze to the dilapidated little town of Stowmarket, fully expecting to find that the "pensive public" there will now be reassured

and quite at its ease. But Stowmarket answers by sending word that two more explosions have taken place, just two days after the article was printed. It appears that certain acid tanks used in the process of manufacture were left open to the weather, and that the rain fell into one of the tanks and caused a chemical action which resulted in a loud and most disquieting "bang." The concussion rang through the town ; but as nobody was killed and nothing was knocked to pieces except the tank, Stowmarket again subsided into its accustomed resignation. The same thing, however, happened to another tank on the evening of the same day ; still nobody was killed or maimed, and at Stowmarket, as in the South-American towns, where earthquakes are of regular occurrence, they have learned to be perfectly placid at what might terrify ordinary persons, except, indeed, when limbs and trunks of exploded human beings are flung about the streets and fields. It must nevertheless, be rather a trying spot for anybody with uneducated nerves, since the more Professor Abel answers for the good behaviour of his patent the wilder its conduct seems to become. Stowmarket has a right to ask that these latest vagaries of the commodity shall be distinctly explained. The Professor is, no doubt, right , but in that case the gun-cotton must be most pertinaciously wrong, and assuredly the police of practical science should be set to investigate the case.

INFLAMMABILITY OF GUN-COTTON.

In consequence of some experiments on the Inflammability of Gun-cotton by an electric spark, Dr. Bleekrode tried also to wet this substance with a very combustible liquid, the bisulphide of carbon. The experiment proved that, in this case, only the liquid took fire, while the cotton, which was in the middle of the burning liquid, remained without alteration, resembling a block of snow slowly melting; the experiment was repeated by wetting the gun-cotton with ether, benzine, and alcohol, always with the same results, and without alteration in the cotton. According to Dr. Bleekrode this is explained by the results said to be obtained by Professor Abel in his researches on the combustion of gunpowder and of gun-cotton, experiments which appear to indicate that if some obstacle should prevent the gases generated by the first action of heat upon the cotton from surrounding entirely the lighted extremity of the cotton, the ignition of these gases cannot follow; and as the rapid and complete combustion of the cotton is due to the high temperature produced by such ignition, the momentary extinction of the gases, in conjunction with the great quantity of heat rendered latent at the moment in which they are formed, compels the gun-cotton to burn slowly, in an incomplete manner, similar to a destructive distillation. Dr. Bleekrode remarks also that a bottle filled with gun-cotton can be kept under a stratum of bisulphide of carbon or benzine without any danger of explosion in case of fire.—*Mechanics' Magazine.*

IMPORTANT GUNPOWDER EXPERIMENTS.

Some very important gunpowder experiments have been made at Woolwich. The results, briefly stated, are such as to estadlish this proposition beyond doubt, and it may now be taken as certain, that the 35-ton gun, with its present calibre of 11·6 in., will not burn more than 110 lb. of gunpowder at one discharge, if so much. As it is thought necessary to have a gun that will burn 115 lb. or more, it remains to be decided whether a larger gnu shall be built, or the calibre of the present one enlarged; anb at all events, experimentally the latter course will probably ecqdopted. It has been proved by the tests which modern research has rendered easy, that a certain charge exercises less pressure upon the interior surface of a 12 in. than a 10 in. gun, and hence it is concluded that by enlarging the bore of the big gun half-an-inch, the decreased thickness of the walls will be no element of weakness, inasmuch as the lateral strain will be diminished. The other experiment took place in the afternoon, at the lower practice range, in the marshes, and was designed to assist the investigations in which the officers of the Laboratory are engaged, under the direction of the Home Office, to insure greater safety in the manufacture of ammunition. These investigations have been in progress since the late explosions at Birmingham, and Captain Majendie, assistant superintendent, who conducted the above trial, has been engaged in an inspection of most of the public and private works throughout the country. Being anxious to ascertain whether the regulation distance of 20 yards between the workshops was sufficient, consistent with the presence in each shop of the regulation quantity of 50 lb. of powder, Captain Majendie had erected five rough sheds 20 yards apart, and placed 50 lb of gunpowder in the one which stood in the midst, a smaller quantity being strewn upon shelves on all the others. The charge being fired, the shed in which it occurred was blown into a thousand fragments, but, though in some cases the powder had been shaken off the shelves of the other sheds and a few timbers started, none of the powder had been ignited. It would, therefore, appear that an isolation of 20 yards is sufficient, and some gunpowder manufacturers who had been invited to witness the experiment were much gratified by the result.—*Mechanics' Magazine.*

THE PRESSURE OF FIRED GUNPOWDER.

In the course of a lecture on the above subject, Captain Noble, F.R.S., narrated how he, Sir W. Armstrong, and Mr. Abel had made many experiments at Elswick They first determined the pressure of fired powder in various parts of the bores of guns by means of a "crusher" arrangement, in which the pressure first falls on a steel piston, which then crushes a cylinder of copper, and the amount of crush of the copper determines the pressure. He also narrated how he had succeeded in firing powder, in

quantities of $\frac{3}{4}$ lb. at a time, in closed vessels. When the gases were afterwards allowed to escape, they blew off with an angry screech, and were accompanied by no smoke of any kind; all the solid residue was left in the vessel for examination. The following were the general results of all the experiments:—"1. The maximum pressure of fired gunpower, unrelieved by expansion, is not much above 40 tons to the square inch. 2. In large guns, owing to the violent oscillations produced by the ignition of a large mass of powder, the pressure of the gas is liable to be locally exalted, even above its normal tension, in a perfectly closed vessel, and this intensification of pressure endangers the gun without adding to useful effect. 3. Where large charges are used, quick-burning powder increases the strain upon the gun without augmenting the velocity of the shot. 4. The position of the vent or firing point exercises an important influence upon the intensity of wave action, and in further enlarging the dimensions of heavy guns we must look to improved powder and improved methods of firing the charge, so as to avoid as much as possible throwing the ignited gases into violent oscillation. 5. In all cases it is desirable to have the charges as short as possible, so as to reduce the run of the gas to the shortest limit. Hence the increase of the diameter of the bore by shortening the charge will tend to save the gun from abnormal strains."

CHEAP OXYGEN.

MM. Tessie du Motay and Marechal, who have lately discovered a mode of obtaining Cheap Oxygen for illuminating and medical purposes, from the manganates of soda, have sought a more practical and economical method of producing hydrogen by the decomposition of water by means of carbon, and they have discovered the following method, which has given the most extraordinary results. Alkaline and earthy alkaline hydrates, such as the hydrate of potash, soda, strontium, baryta, chalk, &c., mixed with charcoal, coke, anthracite, pit coal, peat, &c., and heated to a red heat, are decomposed into carbonic acid and hydrogen, without further loss of heat than that due to the production of the carbonic acid and hydrogen. The hydrates of potash, soda, &c., and more especially the hydrates of chalk or lime, decomposed by the coal into hydrogen and carbonic acid, can be used indefinitely in this process, provided they are moistened each time with water, so as to reproduce the decomposed hydrates. In this operation, the hydrogen gas is generated without any special production of steam, and may thus be produced without any other generating apparatus than the retorts themselves. These retorts, not being exposed to the direct action of the steam, are not subject to any interior alteration or damage. It follows, therefore, that the hydrogen gas produced by the decomposition of the above-named hydrates by means of carbon can be generated at a very small cost, and with the same facility, as car-

buretted hydrogens from the distillation of pit-coal or other organic hydro-carbon matter. These alkaline and earthy alkaline hydrates may be mixed with the different mineral or vegetable combustibles, either in a definite chemical proportion, or without a fixed or determinate proportion, and in any suitable distilling or heating apparatus, in order to produce, when heated to a red heat, hydrogen gas for illuminating and heating purposes. The advantage of the production of hydrogen as cheaply as oxygen, which has been obtained, is likely to create a revolution in many industries, and especially in metallurgy. A cheap method of producing a great heat in order to reduce metals, such as platinum, gold, silver, and iron, has long been sought for in Europe, where the oxyhydric blowpipe is now used to melt the platinum in a calcium crucible. By this discovery it becomes possible to obtain an immense heat, which could be regulated by a simple tap. Enamellers and porcelain makers may thus get rid of one of their greatest troubles.—*Journal of the Society of Arts.*

THE OXYHYDRIC LIGHT.

A French chemist has discovered a light as superior to gas as gas was superior to its predecessor, oil. An opportunity will soon be afforded of beholding this beautiful, clear, and healthy light, as the officials of the Crystal Palace Company have laid pipes, placed gasometers in position, and in the course of a few days will illuminate their crystal fountains and rare works of art with the new Oxydydric Light; and in order that the public may have ocular demonstration of its vast superiority over gas, the lights will alternate, and then the dull yellow haze of the flickering gas lamp will become doubly so in the steady, bright light emanating from the other, which is so intense that it causes the flame of gas to cast a shadow itself on the wall it is intended to illuminate.

This new light can be obtained at a much lower rate than gas; and it is not only brilliant and clear, but healthy.

Above the issue aperture in the ordinary gas lamp, when lighted, there is a dark space surrounded by the flame, with sparkling atoms floating upwards, many of which escape unconsumed, and pollute the surrounding air, much to the injury of eyes and lungs, while others that enter the flame in passing through it are only partially consumed, and in the shape of smoke or dust escape into the surrounding atmosphere, to the detriment of pictures, ceilings, or gilt frames. &c. Nothing of all this occurs with the new light. As the public will be enabled to judge for themselves, we shall take a future opportunity of giving the full results of this experiment in illumination, not only from a scientific and economical, but a practical point of view: and we commend the public spirit of the management of the Crystal Palace in giving this evidence that they are alive to the necessity of early adoption in the matter of so great an improvement.—*Mechanics' Magazine.*

NEW SIGNAL LAMP.

SOME experiments have been made in the Thames with Holmes's Self-lighting Inextinguishable Signal-Lamp, with apparently much success. The lamp is a cylinder of tin, with a conical top, this is filled with a phosphide of calcium, prepared by the inventor. When the lamp is thrown into the water, that fluid, entering the cylinder, effects the decomposition of the phosphide; and phosphuretted hydrogen with phosphurous vapour escapes in great quantities, takes fire spontaneously, and burns with a brilliant light.

OZONOMETRY.

DR. MOFFAT has communicated to the British Association a paper, in which he states that ozone test-papers do not become permanently coloured in the neighbourhood of cesspools; and that the brown colouration, when formed, is removed by the products of putrefaction. He also states that light, the humidity of the atmosphere, and the direction of the wind, influence the colouring of test-papers. Moisture with heat accelerates the chemical action, while a strong wind causes a greater amount of ozone to impinge upon the test-paper in a given time. To counteract the effect of these, he recommends that the test-papers be kept in a box. He next described a tube ozonometer which he had in use, and gave results obtained by an aspirator ozonometer, the results obtained by which, however, were not satisfactory.

ON attempting the repetition of Schönbein's experiment, showing the formation of ammonium nitrite during the combustion of hydrogenous substances, by drawing air from the lower edge of the flame of a Bunsen burner, through an acidulated solution of potassium iodide and starch, C. Than obtained the blue colouration he sought, but at the same time observed that it was accompanied by a strong odour of ozone. This led him to suspect some mistake, and he therefore substituted pure water for the iodide solution, and after drawing air from the lower edge of the flame for a considerable time, tested it with potassium iodide and starch, and, as he imagined, without finding any trace of ammonium nitrite. The colour in the previous instance had therefore been caused by ozone. Subsequent experiments proved that it was also produced during the combustion of hydrogen, candles, alcohol, &c., or any hydrogenous substance. The air is drawn from the lower edge of the flame, where the cold air impinges on it through a very fine tube, and by a rapid current, care being taken that no portion of the flame is drawn in, as in that case the combustible gases destroy the ozone completely. Ozone is likewise produced when a strong current of air is blown through the upper part of the flame. By Clausius and Soret, ozone is represented by the formula O_3, and adopting this expression, M. Than explains its

production in the foregoing experiments thus:—In the combustion of hydrogen, the two atoms constituting a molecule are capable of separating the two atoms forming a molecule of oxygen, combining with one of which they form water, whilst the other atom of oxygen combines with a fresh molecule of oxygen and produces ozone, as follows:—

$$H_2 + O_2 = H_2O + O : O + O_2 = O_3$$

—"Zeit. fur Chemie," vii. 92.

Dr. Debus has delivered to the Chemical Society a lecture "On Ozone." The first who had observed that the passage of electric sparks through oxygen brings about a change in the properties of this gas was Van Marum. The next to take up the subject was Schönbein, in 1840. He ascribed the peculiar odour, and the more energetic oxidising properties of the altered oxygen to a substance which he termed ozone. He also found that ozone may be prepared by many other methods. His experiments, however, led to no possible results as regards the nature of ozone. It was through the researches of Marignac and De la Rive that ozone was shown to be nothing but an allotropic modification of oxygen. Dr. Debus then discussed the question whether there existed another modification of oxygen called antozone, and answered the proposition negatively—the substance called antozone was only peroxide of hydrogen. The lecturer concluded by calling special attention to one of the characteristic reactions of ozone, viz, the decomposition of potassic iodide, which reaction is differently explained by the various observers. Schonbein has shown that potassic iodide protects free iodine against the action of potassic hydrate. It may be assumed that potassic hydrate and an iodine solution react upon one another thus—$KHO + I_2 = KIO + HI$, and then $KHO + HI = KI - H_2O$; if now an excess of potassic iodide be added, the potassic hypo-iodite and potassic iodide produce again potassic oxide (which becomes in its turn hydrate) and iodine, and the excess of iodide prevents the action of KHO on the iodine, but not that of the latter on starch.

THE DANGER OF MINERAL OILS.

Professor Attfield, in a letter to the *Times*, has drawn attention to the Fact that many conflagrations resulting from the incautious use of the different varieties of Mineral Oils are due to ignorance on the part of the public respecting the relation of those liquids to fire. He has also shown that paraffin oil, petroleum oil, &c., being sold and used under the name of lamp oil, most consumers naturally treat them with neither more nor less care than is observed with sperm or colza and the old vegetable lamp oils; whereas in the readiness with which they catch fire they more closely resemble turpentine or spirits of wine, and should be handled, carried, and stored with all the precautions commonly adopted in manipulating these inflammable substances. The

Professor then ventures to point out one other, and the only other dangerous property peculiar to mineral illuminating oils—one which also is liable to produce serious results in proportion as it is unknown or unrecognised—their property of giving off vapour, and under certain circumstances of their being entirely converted into vapour, which with air forms a mixture which will explode on the approach of flame.

It appears that in Upper Whitecross Street, a boy having dropped a piece of lighted paper into the bung-hole of an emptied mineral oil barrel, a loud explosion followed, the head of the cask was blown out, and some children who had gathered round the cask were more or less injured. Professor Attfield believes that the barrel had contained, not paraffin oil nor petroleum oil, but petroleum spirit, the vapour of which, rising from the saturated staves, had mixed with the air in the barrel and formed an explosive atmosphere.

Petroleum spirit is largely used as lamp oil by the poor. At all common temperatures it gives off vapour sufficiently fast to produce with the air in the vicinity a mixture having properties identical with those of a mixture of coal gas and air, that is, it will explode the moment it is ignited. Now, whereas the leakage of gas into the air of a room is known to most people to be attended by danger if a flame is allowed access, the escape of mineral oil vapour into a confined space of air is not so generally known to be an exactly similar operation attended by similar danger. Petroleum spirit always emits such vapour; petroleum oil must be warmed to the temperature of a hot summer's day before it evolves the vapour, and paraffin oil must be much warmer than that; still all the mineral oils are far more readily vaporised than the old animal and vegetable oils. Indeed, the latter are not truly vaporisable at all, requiring to be made as much hotter than boiling water as that is hotter than freezing water before they afford inflammable vapour. All oily and fatty substances burn more freely than most things, but during the time that the heat of a great fire is decomposing the so-called fixed vegetable oils and animal fats and feeding itself with the gases produced, the mineral oils, being volatile, are at once and directly converted into immense tongues of vapour or gas, hence they supply fuel to and spread a fire with a rapidity unknown and impossible before they become articles of trade.

Mineral oil fires and explosions are becoming common. The more spirituous kinds cause explosions in bottles, cans, barrels, and ships' holds, whence result frights, accidents, and conflagrations, while the other varieties, stored indiscriminately and without proper care in the cellar of the shopkeeper or the warehouse of the dealer, stand ready to catch light or feed the flames of a fire with a quickness unequalled by any common combustible, and not excelled by turpentine or brandy. Such deplorable consequences result, I maintain, not so much from the peculiar properties of these justly valued oils as from the ignorance of

the public respecting those properties. The facility with which mineral oils catch light, and their readiness to assume the condition of vapour that give with air an explosive mixture (for neither the liquid nor vapour is itself explosive), are facts not generally recognised; hence, in addition to accidents caused by wilfulness like that of a Paris *Pétroleuse* or by carelessness, we have many produced through ignorance, and these are preventable. When those who possess the requisite knowledge have given it, the Press disseminated it, and the public accepted it, such accidents will cease to occur. Till then they will continue to happen, for the consumption of these cheap and brilliant illuminating agents is largely and deservedly on the increase.

GRAPHITE FROM STYRIA.

ANALYSIS of samples from the mines of the Triemen-Rottermann Mining Company, which extend from Gaishorn to Lorenzen, and from Singsdorff to Einod, near Rottenmann, Upper Styria, have been made by J. Stingl. Three samples of crude graphite yielded—

	1	2	3
Carbon .	. 85·00 p.c.	87·16 p.c.	82·21 p.c.
Ash .	. 14·89 „	12.66 „	17.92 „

Another specimen collected before elutriation and removal of included quartz, had the following composition, carbon 82 4 p.c., silica 12·38 p.c., alumina 3 9 p.c., oxide of iron 0·53 p.c., mangano-manganic oxide 0·62 p.c., lime 0·02 p.c.—*Mechanics' Magazine.*

HYDROGEN IN IRON.

PROFESSOR JACOBI, of the Academy of Sciences of St. Petersburg, having examined iron deposited by galvanic processes, states that he finds that such iron always contains a considerable quantity of hydrogen, retained by occlusion like that discovered by Professor Graham. Mr. R. Lenz describes his researches on the same subject, in the *Annalen des Physik und Chimie*; saying that all iron deposited by electrolisis contains as much as 185 times its proper volume of hydrogen, azote, carbonic acid, and oxide of carbon, the largest part being hydrogen. As long as the metal retains these gases its state is considerably changed, but it regains its primitive state when they have been expelled by heat.—*Ibid.*

GALVANISED IRON.

THE zinc in galvanised iron exists in two states. The state which constitutes its value is that of an actual alloy with the iron; but besides this, there remains a considerable quantity of zinc which is merely adherent mechanically. A method has long been required for ascertaining with facility, and a certain degree of accuracy, the extent to which the zinc has combined

with the iron, and if this combination is perfect throughout the plate. Mr. T. Bruce Warren has recently discovered a mode of effecting this desideratum. When mercury is rubbed over a perfectly galvanised iron plate, it adheres nowhere; but if part of the zinc is merely mechanically attached, in that place the mercury forms an amalgam with it, and attaches itself firmly. To estimate the exact amount of zinc combined with the iron, Mr. Warren detaches a sample from the particular set of plates or wires to be tested, cleanses it with dilute sulphuric acid, and then immerses it for from four to eight hours in mercury. The difference between the weights before and after immersion will be the amount of uncombined zinc. The piece is then heated in a deoxidising flame, and the weight once more taken; the amount lost will, in this case, represent the quantity of zinc which was actually alloyed with the iron.—*Ibid.*

THE MALLEABLE IRON MANUFACTURE.

The new President of the Iron and Steel Institute, Mr. Bessemer, in his opening address, went into the history of the Malleable Iron Manufacture, and it dealt at length with the problems to be solved in the process of mechanical puddling, the successful accomplishment of which, he said, presented so many practical difficulties as to have hitherto heavily taxed the inventive talent and perseverance of many able men. He touched upon the experiments in Wales, France, and in America, as well as in different parts of England, on this point, and he held that much difficulty had been overcome in its now being established that iron, as a simple elementary substance, was the same over all the world, and only differing in the quantity and quality of deleterious matter which the ore contained, thus dispelling the long-established rule-of-thumb notion that the various qualities of iron of different districts were the inevitable result of some radical difference in the iron itself. He proceeded to deal with the manufacture of steel, and gave some interesting stories of the steps by which the manufacture of this material had reached its present stage, and he dwelt upon the happy results which might be expected from investigations by the Institute of various problems which have still to be solved. The address was very warmly received.

For some time past we have been entirely depending on Bolivia for supplies of bismuth, and the supply being rather scarce, it has commanded good prices, but we see with pleasure, in the *South Australian Register*, that it is found in large quantities in Australia, especially in the mines of Balhanisa, where works are already being constructed for its extraction from the ore.

EXTRACTION OF SILVER.

The *Mining Journal* mentions a new and very efficient mode for the Extraction of Silver. Finely ground red ore is first treated with a hot solution of chloride of copper and salt, when the powder becomes black from the formation of sulphide of copper and sulphide of the ore of silver, the antimony being converted into the chloride, and entering the solution. The addition of a second portion of chloride of copper and salt to the precipitated sulphide of silver, in the presence of zinc, reduces the silver almost immediately to the metallic state. In this case the copper again forms a sulphide with the sulphur, in combination with the silver, thus forming chloride of silver, which in its turn parts with its chlorine to the zinc.

NEW MINERAL.

Menaccanite is the name given to an oxide of titanium and iron, which was found in the parish of Menaccan, near the Lizard Point, in Cornwall, many years since, in the state of small black grains. Recently, the same mineral has been discovered in a crystalline state at Porthalla, which is the first time it has been found in this condition. This mineral, which promises to be valuable as producing a superior description of iron, is said to exist in a massive state in quantity in the locality. At present we are dependent on Norway for our supply.—*Athenæum.*

BURNT IRON AND STEEL.

A paper has been read to the Chemical Society, on "Burnt Iron and Burnt Steel," by Mr. W. M. Williams. Iron which has been damaged by re-heating, or excessively heated and exposed after balling in the puddling furnace, is designated "burnt iron" by the workmen. Burnt iron is brittle, its fracture is short, and what is called crystalline; it has lost the fibrous character of good iron. If steel is raised to a bright red heat, and suddenly cooled, it is rendered hard and brittle, but these conditions may be modified by the process of tempering. If, however, the steel be raised to a yellow or white heat, and then be suddenly cooled, it is no longer capable of being tempered by mere re-heating The fracture of burnt steel presents a coarse grain and a crystalline appearance. Careful investigation, however, shows something more, viz., that the facets of the aggregated granules have a more or less conchoidal form. The name of "toads'-eyes" has been given by practical men to these concavities. Mr. Williams found that a piece of burnt iron contained oxide of iron dispersed through its mass. A sample of burnt steel, however, investigated in the same manner as the iron, showed no indications of the presence of oxide. In the case of steel, the burning is limited to the oxidation and consequent removal of the carbon, which takes place even at a low

red heat. The "toads'-eyes," or conchoidal facets, of the so-called crystals, Mr. Williams explains by supposing a piece of steel, at the temperature most favourable to the rapidest endosmosis of oxygen and the exosmosis of carbonic oxide, to be suddenly cooled, and the possible occlusion of the carbonic oxide to be arrested; the result would be a certain molecular disintegration and porosity of the steel presenting those conchoidal spots.

METEORIC IRON.

The Swedish Arctic Expedition has brought from Greenland specimens of Meteoric Iron, two of them of enormous size. One, placed in the Hall of the Royal Academy of Stockholm, measures about 42 square feet, and weighs nearly 21 English tons; another, which has been presented to the museum of Copenhagen, weighs about six tons.—*Athenæum*.

SILVER-PLATING.

In the January number of *Polytechnisches Journal Von Dingler* is a simple process by Prof. Boettger for testing the genuineness of silver-plating on metals, which may be of value to many. The metallic surface is carefully cleaned, and a drop of cold saturated solution of bichromate of potash in nitric acid is placed upon it, and immediately washed off with cold water. If the surface is silver, a blood-red spot of chromate of silver is formed, whereas on German silver or Britannia metal the stain is brown or black.

GLASS AS A NON-CONDUCTOR OF HEAT.

Glass is practically a non-conductor of heat as well as of electricity. A practical example of the latter may have been seen in the use of glass as an insulator, a non-conductor for telegraphic purposes. It is difficult to draw the line of non-conduction, but bad conductors of heat are practically assumed as non-conductors. The question of conduction is purely one of degree. Let two rods of equal size and length—but one of copper and the other of glass—be brought together, and have at their extremity a small weight or marble attached by wax. Apply a spirit lamp to their ends, touching each other so that the heat be equally applied; in the copper, owing to its being a good conductor, the wax will rapidly melt and let the weight drop; while in the case of glass, owing to its being a very bad conductor, a very long time must elapse before such a result can happen.—*Journal of the Telegraph*.

NEW GLASS CEMENT.

Professor Bottger prepares Cement of divers colours and

great hardness by mixing various bases with soluble glass. Soluble soda glass thoroughly stirred and mixed with fine chalk, and the colouring matter well incorporated, sets in the course of six or eight hours as a hard cement; it is capable of a great variety of uses. Well sifted sulphide of antimony gives a black mass, which, after solidifying, can be polished with agate, and then possesses a fine metallic lustre. Fine iron-dust gives a grey-black cement; zinc dust makes a grey mass, exceedingly hard, which, on being polished, has a brilliant metallic lustre, so that broken or defective zinc castings can be mended and restored. Carbonate of copper gives a bright green cement; sesqui-oxide of chromium gives a dark green; Thenard's blue, a blue; litharge, a yellow; cinnabar, a bright red; carmine, a violet-red cement. The soluble glass with fine chalk alone gives a white cement of great beauty and hardness. Sulphide of antimony and iron-dust in equal proportions, stirred in with soluble glass, afford an exceedingly firm, black cement; zinc dust and iron in equal proportions yield a hard, dark grey cement; all adhere firmly to metal, stone, and wood. As soluble glass can be kept in liquid form, and the chalk and colouring matters are cheap, the cements can be readily prepared when wanted, and the material kept in stock, ready for use, at little expense. Soluble glass is fast becoming a most important article of chemical production.—*Mechanics' Magazine.*

IRRIGATION V. DISINFECTANTS.

Ever since the commencement of the sewage difficulty, the rival claims of the Irrigation and Disinfectant partisans have been prominently placed before the public; yet the problem is still unsolved. The results of irrigation are tangible and appreciable; so also, it is said, are those of the deodorising and disinfecting systems The whole subject is now on its trial, and until the experiment which is being conducted with regard to the sewage of the metropolis is a success or a failure all criticism may be fairly suspended. The task which the Native Guano Company has undertaken to accomplish at Crossness differs in no respect from that which has always constituted hitherto the insuperable obstacle to a satisfactory solution of the important question. It is not intrinsically of an arduous character. It involves only two conditions. The one is the purification of the effluent water; the other, the utilisation of the solid residue. Both of these must, however, have a reference to some standard. The former ought to attain to that prescribed by the commissioners appointed to inquire into the pollution of rivers. Perhaps this is of a rather stringent character. One thing is nearly certain, viz. if the Conservators of the Thames elect to adhere to this standard, there will be an end to the experiment to which we have alluded. There is no difficulty in purifying the metropo-

litan sewage to an extent which will allow the effluent water to pass into the river in a state of almost absolute purity compared to the filth which is at present pumped into it. It remains to be seen if the Board of Conservancy will be content with an amelioration instead of a cure of the evil. That the result of the forthcoming experiment will very materially improve the present condition of the sewage discharged into the Thames we have not the slightest doubt. That it will not purify the effluent water so as to bring it up to the standard of the Rivers' Pollution Commissioners we have also not the slightest doubt. But between this standard and that which will probably satisfy the conservators there is, fortunately for the experimentalists, a wide margin. So far as the pollution of the Thames is concerned by metropolitan sewage, the term applied to its guardians is a complete misnomer. They are able to hold their own with the small fry, but when they have to tackle a big fish, such as the Metropolitan Board of Works, they are nowhere. They give no mercy to the riparian small towns and villages situated beyond the municipal boundary, and yet allow the whole sewage of the metropolis to be discharged into the river they are presumed to conserve.—*The Engineer*

SEWAGE IRRIGATION.

A PAPER on this important inquiry has been read to the British Medical Association, by Mr. William Hope, the well known engineer, who had been invited to speak on Sewage Irrigation in connexion with public health. In the course of his address Mr. Hope controverted the views set forth by some chymists regarding the sewage irrigation being the cause of parasites in animals, parasites which were likely to react on the human system; but he quite allowed that sewage irrigation, unless properly conducted, would cause lands to be pestilential swamps. In answer to questions, Mr. Hope agreed that as the irrigation was conducted near Malvern, in Worcester, it was likely to be the cause of fever in the adjacent places, and regarding the opinion of farmers as to the use of sewage for irrigation, he said that in two days he obtained favourable replies from 69 Essex farmers and owners of land representing 40,000 acres, in answer to his question whether they were ready to take the sewage if the Metropolitan Board of Works or any other body should find itself in a position to carry out the long proposed utilisation of London sewage. It transpired in the course of the proceedings that the "three towns" and the independent districts in the neighbourhood empty their sewage into the sea, as visitors have no difficulty in discovering at low water, and Mr. Hope pointed out that whatever parasites might be generated in the sewage would indeed be more likely to return in the fish caught in the harbour than they would in what must be to them a great convulsion of nature when they passed from a town and were on the land laid open to long exposure.

PRODUCTIVE POWERS OF SOILS.

Dr. Völcker has delivered, before the Chemical Society, a lecture "On the Productive Powers of Soils in Relation to the Loss of Plant Food by Drainage." The lecturer began by showing the futility of the belief that a soil analysis could reveal whether a land was productive or not. To those who only imperfectly know the teachings of modern agricultural science, it appears very simple to remedy a deficient soil by finding out, through analysis, the wanting constituents, and then to supply them. But this is not so. Not only is it difficult exactly to analyse a soil, but many other conditions besides the composition of a land have to be observed. The state of combination in which the mineral constituents of a land are found, the physical condition of the soil, the presence or absence of some matter injurious to the growth of plants — all these are so many important points upon which soil analysis throws no light whatever. The lecturer equally opposed the views of those who advocate that in a system of rational farming there should be kept up a debtor and creditor account as regards the constituents which are removed from the soil in the crops grown upon it, and the quantity of fertilising matter restored to it in the shape of manure. The fertility of the soil cannot be maintained, much less increased, if only as much fertilising constituents would be applied to the land as one removes from it in the crops. Dr. Volcker then discussed the relative values of various mineral salts as manures, quoting, in support of his views, the results of the classical field experiments of Lawes and Gilbert; and this then led the lecturer to speak of the examination of land drainage-waters. Lawes and Gilbert, throughout a long series of experiments on the growth of wheat, have experienced a great loss of nitrogen. The amount of nitrogen supplied in the manure was greater than that recovered in the increased produce. It appeared to Dr. Völcker that the nitrogen lost might have passed into the drains. Careful collection of such drainage-waters and their analysis proved Dr Volcker's supposition to be correct. It became clear that in whatever form the nitrogen is supplied to the soil, a large proportion of it is carried off, chiefly in the form of nitrates. At all times of the year, but especially during the active period of growth of the crops, nitrates are found in the watery liquid which circulates in the land, whereas ammonia salts are never met with in any appreciably large quantities. It may therefore be assumed that it is chiefly, if not solely, from the nitrates that the crops build up their nitrogeneous organic constituents. Dr. Völcker's analysis of drainage-waters further showed that potash and phosphoric acid, which certainly are the most important mineral constituents for the plant, are almost entirely retained in the soil; whilst the less important, as lime, or magnesia, or sulphuric acid, pass with greater readiness out of the land.

AGRICULTURAL CHEMISTRY.

A CIRCULAR letter on "Technical Education for the Sons of Farmers" has been printed and extensively circulated. The author, Mr. W. Little, of Heckington, Lincolnshire (remembered for his important improvements in printing machinery), insists "that the future generation of farmers should have such a general knowledge of science as will enable them to correctly appreciate the value and properties of manures," the nature of soils, and a knowledge of all that belongs to drainage and irrigation systems. The purpose is to establish, if possible, science classes in all the large agricultural districts.

ANTIDOTE TO STRYCHNINE.

DR. HERBERT, of New York, in a late case of Poisoning by Strychnine, as a *dernier ressort* gave doses of 90 grains of bromide of potassium, every half-hour. In two hours the patient could move his arms. The dose was then diminished to 1 drachm, every fifteen minutes, for an hour; and as the patient became easier, still further lessened, and at increased intervals, according to symptoms, during the following day and night. In thirty-six hours the man was able to walk about, only feeling a little weak, with an occasional slight spasm.—*Mechanics' Magazine.*

COCCULUS INDICUS IN BEER.

A SOLUTION of sugar of lead, containing ammonia, precipitates sugar, dextrine, gum, &c., but not picrotoxin, the poisonous principle of the seeds of Cocculus Indicus. Upon this Fact is based a ready method for the detection of this deleterious drug in adulterated beer. The beer is first treated with ammonia until it smells strongly, allowed to settle, and as soon as the liquid is clear, an alcoholic solution of acetate of lead is added until another precipitate is formed. The excess of lead is removed by sulphuretted hydrogen, and the filtered liquid boiled down. If the residue be then shaken up with ether, and left to settle the supernatant liquor will contain the picrotoxin if any be present. —*Ibid.*

ANTIDOTE TO CARBOLIC ACID.

CASES of accidental poisoning with this substance are unfortunately of rather frequent occurrence, whilst a specific antidote has hitherto been wanting. Dr. T. Husemann, from numerous careful experiments both chemical and medicinal, advocates the use of a strong solution of saccharate of lime, of course to be taken as soon as possible.—*Neues Jahrbuch für Pharm.*

ANTIDOTE TO PHOSPHORUS.

IT is well known that many metallic salts, such as acetate of lead, sulphate of copper, salts of mercury, bismuth, &c., are with-

drawn from their aqueous solutions by vegetable charcoal; but to a still greater extent by mineral black. Carbon also absorbs many alkaloids from their solutions, and it is upon this property that the process is based for the detection of strychnine in beer by its means. MM. Eulanberg and Vohl now show that phosphorus is also absorbed by carbon, and to such an extent that carbon taken in the form of pills constitutes a complete antidote to the poison, and relieves those who have to manipulate phosphorus from all the disastrous consequences hitherto accruing. The experiments they have made upon animals have yielded exceedingly favourable results They prepare the animal-charcoal pills by powdering the charcoal and making it up with a little gum. In match-factories they find the results of these pills are better than those obtained by the use of the essence of terebenthine of M. Personne, as the continued use of the latter was found to produce violent headaches —*Mechanics' Magazine*.

THE NEW SUBSTANCE DAMBONITE.

M. Aime Girard has discovered a new substance, Dambonite, in the india-rubber of the Gaboon When treated with a mixture of sulphuric and nitric acid it is transformed into a gummy, thick, and translucid substance When thrown into water it precipitates in the form of flakes, which, when carefully washed and dissolved in boiling alcohol, deposit crystals of nitrated dambonite, which is insoluble in alcohol and detonates under the hammer. The new base, treated with fuming hydriodic acid, yields dambose, which acts in the same way.

TESTING PETROLEUM.

At the Indianapolis meeting of the American Association, Dr Van der Weyde has described a plan for determining the burning-point of petroleum oils The amount of combustible vapour evolved by a sample of these oils at a given temperature, depends, not upon its gravity, but upon its quality Two oils (for example) of the same gravity need not necessarily evolve at 100° Fahr. (the accepted standard temperature) the same amount of vapour; since one of them might be a mixture of light and heavy oils, the mean specific gravity of which might be the same as that of the other. The amount of vapour given off by the two samples at the same temperature would, however, be very different, since the one adulterated with the light oils would evolve considerably more than the simple heavy oil of the other sample The author has taken advantage of this Fact, and simply measures the amount of vapour given off by the oil at the standard temperature; this amount is compared with computed or experimentally established quantities, and hence he is able to announce the quality of the oil. A graduated glass-tube is filled with the oil, inverted and immersed in a vessel of water of the tempera-

ture of 110° F., and after a few minutes the amount of vapour given off is read from the graduation. The avoidance of the danger from fire, and the small liability to error, afford strong recommendations for the use of this plan of testing the vapour points of mineral oils.

YEAST.

Under the name of "Viennese Yeast" a ferment is in general use on the continent, which has greater strength and more regularity of action than ordinary yeast. It appears that to it the superiority of German beer and German bread is generally attributed. It is prepared in the following way:—Three kinds of grain, viz., Indian corn, barley, and rye (all sprouting), are powdered and mixed, and then macerated in water at the temperature of 65 deg. to 75 deg Cent. In a few hours saccharification takes place. The liquor is then racked off, allowed to clear, and alcoholic fermentation is set up by the help of a minute quantity of yeast As fermentation progresses the globules of yeast reproduce themselves by a species of budding, engendering at first very small globules, but these rapidly increase in size, and attain a diameter of 10 to 12 milliémes. Carbonic acid is disengaged during the process with so much rapidity that globules of yeast are thrown up by the gas, and remain floating on the surface, where they form a thick scum. This scum is carefully removed, and constitutes the best and purest yeast. When drained and compressed by a hydraulic press, it can be kept from eight to fifteen days, according to the season.

SPURIOUS TEA.

Dr. Letheby, the Medical Officer of Health for the City, has brought before the notice of the Commissioners of Sewers the fact that a large quantity of Spurious Tea had been sold by auction at the Commercial Sale Rooms in Mincing Lane, and produced samples which had been obtained by one of the sanitary inspectors. That they consisted of tea dust and siftings, and of damaged leaves in a putrid condition, and were, in fact, precisely of the same description as the samples which were the subject of legal proceedings in March 1870. The so-called "Moning Congou" was composed of broken down and rotten tea leaves which had already been used for beverage, and the "orange Pekoe siftings" were made up of similar leaves together with a large quantity of those of other plants. In the scented tea-dust there was a great proportion of earthy matter and iron filings. The tea was sold to the extent of 600 half-chests, and the price realised was from five to seven farthings per lb. He had been informed that it was intended for country use, and that samples had been exposed for sale at Liverpool. He recommended that the matter should

be referred to the Sanitary Committee, with a view to legal proceedings being instituted, and he added that a quantity of similar stuff was then on its way from Shanghai. Mr. Deputy de Jersey suggested that the committee should at once confer with the Government, to obtain assistance, whereby this disastrous and dishonest traffic might be effectually stopped. Hitherto, he said, the committee alone had been almost powerless. Mr. Bedford remarked that a duty of 6*d.* on each pound imported must have been paid. The matter was then referred to the Sanitary Committee.

Mr. J. C. Betts has submitted to the Board of Trade a memorial from the Tea Dealers' and Grocers' Association, representing the retail dealers of the metropolis, setting forth that they desired to draw serious attention to the continued importation of spurious tea, and earnestly requested the intervention of Government to prevent it from coming into consumption by directing the Customs' officers to refuse to receive the duty on any so-called tea which, from well authenticated information and subsequent examination, shall be ascertained to be unfit for human food. The memorialists were informed that a large quantity of this spurious tea had been recently imported, and they felt strongly that immediate action should be taken by the Government, not only on account of the public health, but also for the protection of the revenue, as the consumption of tea would be considerably interfered with if the public mind became imbued with the notion that any rubbish may be imported and sold under the name of tea. They would also submit that it was an injustice to receive the duty on any article which was liable to seizure when offered for sale in the same condition as passed by the Customs. Mr. Betts said Dr. Letheby, as the officer of the City Commissioners of Sewers, had made an analysis of various adulterated teas. In one case he found 25 per cent. of steel filings. Tea was adulterated with willow and other leaves. With respect to one tea called Maloo mixture, it was principally composed of spent or used tea leaves. It was mixed purposely with earthy and other matter for colouring purposes, was exposed to the sun to dry, and gathered a great deal of dirt and filth. Such stuff as this could not be called tea, as it had nothing in common with it. He hoped the Government, in the interest of the public, would take up this question. The City authorities had seized a quantity of tea as injurious to the public health, but a great portion of it had escaped out of their jurisdiction pending proceedings. Mr. Debac said they were anxious to take practical steps to suppress the trade in spurious and adulterated tea. From the great care and caution exercised by respectable dealers in buying teas, spurious tea did not find its way into their shops. Several members of the deputation having explained their views, Mr. Chichester Fortescue said he was obliged to the deputation for the information they had conveyed to him. At the present he did not see how he could take action in the matter. He had

inquired into the law on the subject, and he was of opinion that the Commissioners of Customs had no power to prevent the circulation of tea after the duty had been paid. He was in possession of a great deal of information on the subject, and was in communication with the Chancellor of the Exchequer with reference to it.—*Times Report.*

SPECTRUM ANALYSIS APPLIED TO CHEMISTRY.

MR. DITTE continues his experiments on the Spectra of simple bodies; he now treats of the bodies composing the family of Azote; viz., of Phosphorus, Arsenic, Antimony, and Tin. The spectra are produced by passing the electric spark through their chlorides, taking care to eliminate the bands of the chlorine. The principal Facts are the following:—The spectra increase progressively from the Azote to the Tin; they begin as points very near the orange red, but the most refrangible rays extend themselves more and more towards the violet, in proportion as the properties of the elements under examination approximate to the metallic character. The spectra present three maxima of luminous intensity, coming from the bright bands. These maxima change in position towards the violet, in the transition from Azote to Tin. It results from those experiments that each family of bodies is characterised by a constant number of maxima of intensity, and that these maxima progress towards the violet in a manner which corresponds with the change in the physical properties of the bodies.

CHLOROFORM.

CHLOROFORM, the most important of all anæsthetics, was discovered first by M. Soubeiran, in 1831; then by Baron Justus Von Liebig; and its chemical and physiological properties were more fully investigated by Dumas, in 1835. It is formed by chlorine acting on marsh-gas, and is prepared on a large scale by distilling together bleaching powder (chloride of lime) containing a little quicklime to render it alkaline, water, and spirits of wine, or wood spirit; the distilled liquor is then shaken with several successive portions of distilled water to free it from any soluble impurities, agitated with its own weight of pure oil of vitriol, and lastly, distilled from a mixture of chloride of calcium and quicklime, which removes every trace of water and acid, and renders it much more permanent and safe to use than if these impurities were allowed to remain. The specific gravity of pure chloroform is variously given at 1·497, 1·500, and 1·525; the last density, however, is too high, as the chloroform of the best makers is generally 1·497 or 1·500 It is a dense mobile liquid, having a pleasant ethereal odour and a warm, sweet taste; exposed to the air it rapidly volatilises, leaving no residue; it boils at 141 deg. F., and is not easily made to catch fire, but when it burns it does so with a dull, smoky, greenish flame. Chloroform

vapour is rapidly absorbed by the atmosphere, and this capacity of absorption varies with the temperature, having a certain definite maximum for each degree; for instance, it is found that air at 40 deg. F. will take up 6 per cent. of vapour, while air at 90 deg. F. is capable of taking up 35 per cent. Chloroform is also the best known solvent for camphor, resins, sealing-wax, and gutta-percha; it also dissolves the vegetable alkaloids, strychnia, morphia, quinia, &c., in large proportions, and is very useful as a local anæsthetic in allaying the pain of toothache; as a solvent it will remove greasy spots from fabrics of all kinds, but its chief use is as an æsthetic, of which kind of medicinal agents it is the type. There are several other volatile organic bodies which possess similar properties, but none, so far as we have yet been able to discover, produce the total unconsciousness and muscular relaxation that follow the inhalation of chloroform.—*Mechanics' Magazine.*

ORGANIC COMPOUNDS.

M. Berthold has read an essay on "The Formation of Organic Compounds originating from Azotic Acid.' According to his notion the explosive power of nitro-carbonatic compounds is the result of a kind of internal combustion analogous to that of gun-cotton. There is, however, a difference, because the elements of the azotic acid and those of the combustible principle are intimately united instead of being only mixed as it is in common gunpowder This power is much greater, because the combustion developes more gas and heat, and the heat produced by the combustion is in excess of that created by the previous union of the azotic acid, owing to the organic principle having given less heat.

ALBUMEN.

Albumen is now produced on a large scale at Pesth, Hungary, and in North Germany, from the blood of animals. The serum separating when blood coagulates consists chiefly of albumen. The best quality of albumen thus obtained is transparent and soluble in water, and is used for mordanting yarns and cloth. At Pesth blood is dried in flat iron pans by exposure to air at a temperature at from 100 to 112 deg. F. From 3,000 pounds of blood about 110 lb. of albumen is obtained, at a cost of 29 dols.; 16,200 eggs would yield the same amount of albumen, at a cost of 96 dols. Although the cost of egg albumen is three times as great as that of blood albumen, the former is preferred for dyeing purposes, on account of its purity Blood albumen of a second quality, darker in colour, but nearly all soluble in water, is used largely in the process of refining sugar.

GLUCOSE CONTAINING SUGAR.

Mr. C. H. Gill has read to the Chemical Society, a note "On the Examination of Glucose containing Sugars." It is known that

coloured sugar solutions are decolourised and clarified by the addition of basic lead acetate before they are submitted to optical examination. Mr. Gill found that the power of invert sugar to rotate a ray of polarised light is greatly altered by the presence of that re-agent. The alteration takes place only on the levulose in the liquid; the dextrose suffers no change of optical properties. This alteration is not permanent: on removing the lead or acidifying the liquid the original rotatory power is restored. Mr. Gill employs these latter reactions in order to obtain correct numbers with the saccharometer. He uses a strong solution of sulphuric dioxide, which removes the lead and at the same time bleaches the liquid, but is incapable of inverting cane-sugar in the cold even in 24 hours. The presence of the lead salt in sugar solutions is also disadvantageous when the glucose has to be estimated by Fehling's copper solution, as it partly becomes reduced. and thus necessitates the use of a greater volume of the saccharine solution: the removal of the lead does away with this source of error.

PRESERVATION OF CONDENSED MILK.

Heretofore in preserving crude or condensed milk it has been usual to add to the milk about 20 ounces, more or less, of cane or beetroot sugar, and then to evaporate or condense the milk in vacuo.

Now, according to a patent granted to Mr. J. A. Newnham, of Mallow, County Cork, in place of adding cane or beetroot sugar for the purpose of preserving the milk. he adds to it glucose, which is a sugar less soluble and less sweet than cane or beet sugar, occurring in the juice of many fruits, but best obtained from dried grapes, starch, potatoes, wheat, and other similar articles, called also grape sugar, starch sugar, and diabetic sugar, before, during, or after the usual process of condensation or evaporation. The quantity used is about 20 ounces of glucose to one gallon of milk. In some cases a small quantity of a tasteless antiseptic, such as sulphate or chlorate of potash, may be added to improve the keeping qualities.—*Mechanics' Magazine.*

LUNAR PHOTOGRAPHY.

Mr. Ogier having stated that he had obtained Photographs by Moonlight only, Mr. Baxter, a learned photographer, of Philadelphia, absolutely denies its possibility. In reply. Mr. Ogier repeated his experiments, and offered specimens of the results to all who would contradict his statement. He says there are two sides of the question, the one theoretical, which concerns the explanation of the photogenic power of moonbeams, and the other practical, that is to say, the realisation of the Fact. But the latter can no longer be denied. In about 25 minutes, between the hours of 9 P.M and 1 A M, a landscape photograph may be obtained by the light of the moon. Now, is the moon

only a mirror reflecting the sunlight? The author believes that she must have, in addition, a certain luminous power of her own, since her light makes a stronger impression when she is farther removed from the sun. In fact, the impression is stronger at 10 o'clock than at 9, at 11 than at 10; and the necessary time for producing the impression decreases instead of increasing. If the moon's rays were only reflected light, there would only be the same elements as the rays of the sun, but with less power. Such, however, is not the case, for the moonbeams reproduce colours which it is very difficult to obtain by the power of the rays of the sun, yellow, for instance. It cannot, consequently, be said that the moon only reflects the light from the sun, for if such were the case the photographic impression produced by the moon ought to occupy a space of time proportionate to the intensity of light emitted, which it is not found to do.

Mr. Ogier recommends the exclusive use of a reflector which throws on the object the greatest amount of moonbeams; he uses a collodio-bromo-iodide, and developes with ammoniacal sulphate of iron. These facts are well deserving of the attention of natural philosophers and astronomers.—*Mechanics' Magazine.*

PHOTOGRAPHIC POST.

THE Abbé Moigno has made to the British Association a communication 'On the Photographic Post,' in which he styled Sir David Brewster the father of microscopic photography. He particularly mentioned the labours of Mr. Dancer on this subject, and then described the method adopted during the siege of Paris for printing and circulating despatches and newspapers. He exhibited a film of collodion, a few inches square, on which were 3,500 despatches, and he said, if necessary, one pigeon could bring 50,000 despatches into the invested city.

NEW APPLICATION OF COLLODION.

M. KLEFFEL has discovered that if a glass plate is coated with Collodion in the ordinary manner, and, after the liquid has set, a printed sheet of paper is pressed upon the surface lightly with the ball of the hand, a very exact reproduction of the printed matter will be found impressed upon the collodion after the removal of the paper, the design or type remaining perfectly visible after the complete desiccation of the film. Particularly distinct is the printed matter when the plate is held up as a transparency, or when seen by reflected light, after the surface has been breathed upon, the type or design being somewhat sunken and bright. As a ready method of copying valuable originals, it is suggested, the process might be available, since the necessary manipulations require no more time than the process of copying a written document in the ordinary copying-press.

INFLUENCE OF VIOLET LIGHT.

General A. J. Pleasanton, in a pamphlet presented, by request, to the Philadelphia Society for Promoting Agriculture, states that, impressed with the belief that the actinic rays of the spectrum might be practically employed to stimulate the development of life, he constructed a grapery, in which every eighth row of glass was violet-coloured. In this, cuttings of twenty varieties of grapes, each one year old, and of the thickness of a pipe-stem, were planted. Within a few weeks after planting, the walls and inside of the grapery, which was 84 ft. long, 26 ft. wide, and 16 ft. high at the ridge, were closely covered with the most luxurious and healthy wood and foliage. In the autumn of the following year the vines bore 1,200 lb. of grapes, the bunches being of unusual magnitude, and the year after the yield was two tons.

REECE'S PATENT REFRIGERATING MACHINE.

We have had an opportunity of examining a new machine for the production of cold by the rarefaction of condensed ammonia. It is well known that a gas which has been forced by compression to assume the liquid form will return to the gaseous state when the pressure is removed, and in doing so will abstract heat from any adjacent substances. Ammonia is especially suitable for the utilization of this property, because it is rendered manageable by its ready solubility in water, and also by the manner in which it is expelled from this solution by the application of moderate heat. Mr. Reece's apparatus consists of an upright cylinder, called the analyser, in which a descending current of strong solution of ammonia is met by an ascending current of steam, so that the ammonia leaves the water and is driven off through a tube into a rectifier, where it is freed from any small remaining portion of water that it may have taken over. Thence it passes on into a coiled tube, within which it is rendered liquid by the pressure of its own accumulation, and is then carried on in a liquid form into a receiver, from which it can be liberated at pleasure, and suffered to pass into a refrigerator, in which there is a coil containing liquid destined to convey the cold to the place where it is to be used. This carrying liquid is usually a solution of chloride of calcium, which can be brought to a temperature of 50 degrees below zero without congelation. It is made to circulate through the refrigerator and also round any tanks or other vessels the contents of which are to be cooled, and, in some experiments lately tried, it rapidly froze water contained in large zinc cells, so as to produce plates of ice about 18 inches square and 2 inches in thickness. The ammonia, when it has assumed the gaseous form and has done its work of refrigeration, is conducted into a condenser, in which it is re-dissolved in some of the previously exhausted water, and is made ready to be pumped once more into the analyser without

appreciable loss. At the same time the condensed steam of the analyser can be taken back into the boiler. and the whole process continued for an indefinite time without the introduction of new material. The only power required is for working two small pumps, one of which feeds the analyser with solution of ammonia, while the other keeps the cold-carrying solution in movement. In any factory or place where steam power was already in use this demand would be almost imperceptible; and the only other cost of working is that of the fuel for the boiler fire, which requires only one-fourth as much as the fire of an ether freezing apparatus. Mr. Reece finds that the rarefaction of 130 lb. of ammonia will reduce by 20 degrees the temperature of 600 gallons of water.

For persons who carry on various trades, such as brewing, meat preserving, and many others, in hot climates, Mr. Reece's apparatus will be invaluable, as well as for the economical production of ice for home consumption, and it will also admit of being used to maintain an uniform low temperature in the holds of ships. It is made by Messrs. Pontifex, of King's Cross, at whose works it may be seen in operation.—*Times*.

FREEZING OF WATER.

M. Boussingault has experimented on this subject in vessels so strong as to be able to resist the immense pressure exerted by water by the increase of bulk it gains in taking up the solid state. The water was put in this vessel at the temperature of 4·1° C., and a steel stopper screwed in. The whole was then placed in a freezing mixture and gradually cooled down to 18°C. without any indication of congelation; but as soon as the plug was sufficiently removed to allow of the water having its necessary molecular expansion, ice was instantaneously produced. The first experiments on this subject were the now historical ones, conducted by the Florentine philosophers and by Huygens in 1667. when no vessel was found to be able to resist the pressure. In the present experiments, the bottom and sides are so strong as to be practically unyielding.—*Comptes Rendus.*

EXPERIMENTS ON COLOUR.

Dr. Clerk Maxwell, F R S., has exhibited to the Royal Institution some remarkable Experiments on Light and Colour. Although a mixture of blue and yellow pigments will produce a green colour, the mixture of blue and yellow light produces white. He proved this by projecting two large discs of blue and yellow light upon the screen, and causing them to overlap each other; where they overlapped the colour was not green, but a pure white. He then interposed a lead-pencil in the path of the rays from the two sources of coloured light, so that a double shadow of it fell upon the screen, in the place where the two

discs overlapped each other. The one shadow was a brilliant blue colour, and the other pure yellow.

In another experiment he mixed red and green rays, and they formed a yellow as brilliant as the pure yellow of the spectrum; he proved this by throwing the pure yellow on to the screen immediately after the removal of the yellow produced by mixing red and green light. He showed that the pure yellow could not be decomposed by the intervention of a prism, whilst the yellow produced by the mixed rays could by means of a prism be resolved into the red and green rays of which it was composed.

In the course of the lecture he called attention to the Fact that all persons have a yellow spot upon the retina, which tends to make colour vision somewhat imperfect. The yellow is more pronounced in dark than in fair persons, and it has a tendency to impair vision more when the individual is tired and overworked than when he is well and active. To make the presence of this spot sensible to the observers, Dr. Maxwell threw a disc of light upon the screen, and coloured the disc by making the light pass through a solution of chloride of chromium. The light thus produced is of a red colour, mixed very largely with greenish-yellow rays, which are copiously absorbed by the yellow spot. He then told the observers to wink slowly at the disc, and they nearly all then saw large red cloud-like spots floating over the disc, in consequence of the absorption of most of the rays, with the exception of the red by the yellow spot in the eye. When the disc was gazed at steadily, without winking, the floating red clouds disappeared.

NEW COLOUR.

M. A. Baeyer, in *Ber. Deut. Chem. Ges. Berlin,* has described the production of a New Colour from pyro-gallic acid. Crystals of galleine are first produced, and these are converted into a substance named coruleine. This dissolved in sulphuric acid produces an olive-brown colour, with aniline it forms a rich indigo blue, and with alkalies it gives a fine green.

NEW USES OF PHOTOGRAPHY.

Photography is used by our Government, says the Philadelphia correspondent of the *Photographic News,* in two or three novel yet useful ways, which I must tell you of. A good deal of loss has been sustained by the Pension Bureau, on account of frauds perpetrated by dishonest applicants for pensions. For example, a party would receive his claims at the General Office at Washington, and then quickly apply again at some agency in the larger cities, very often with success. Now his "little game" is blocked. Each day the pages of the receipt books at all the offices are photographed, and copies transmitted to each office; then,

when the defrauder presents his second claim, photography confronts him with his own signature, and the Government is secured. Another use is made of photography by the Customs Department. When goods arrive from abroad in New York for merchants in other cities, they are placed in bonded railway cars, and locked with the "photographic lock" of the Customs House. The lock itself is nothing more than an ordinary padlock, which is provided with an arrangement by which a small piece of glass an inch square is passed over the keyhole, and held in place by a small spring, which cannot be reached without breaking the glass itself. By no possible exercise of ingenuity can the lock be picked or opened without breaking this piece of glass. Here comes in the value of photography. A large sheet of glass, red on one side, is prepared in New York, by marking it off into squares of the proper size. On each square is marked a number in figures and irregular spots in red, the rest of the red surface being cut away with hydrofluoric acid. One of these sheets cannot be duplicated. The government photographer receives them at Washington, and makes three photographs of them, which give perfect facsimiles of the figures and spots on the glass, and then both glass and photographs are cut into small squares corresponding with each other, and packed in boxes. each square of glass having with it three copies on paper. These are forwarded to the officers who will use them. The officer at New York, for instance, whose duty it is, locks the door of the car containing the bonded goods, places the glass square over the keyhole, and forwards the photograph of the same to the officer, at Philadelphia or elsewhere, whose duty it is to receive the goods. If, on the arrival of the car, the lock has been disturbed the inspector is at once aware of it, and the company transporting is liable in bonds required previously. This is an ingenious and practical application of photography to the mechanical arts, and suggests numerous other applications of the art to the safe keeping of valuables, and even the detection of crime, in interference with property, when the progress shall have rendered automatic photography practical, which is already possible. The photographer for the Treasury Department is now engaged in preparing the seals for the new locks, to be used by that department in the transportation of merchandise in bond. and in such other cases where the protection they afford will be necessary. I will try to forward you one soon. Thus photography is winning its way, and daily growing more and more indispensable.

PHOTOGRAPHS FIXED BY VIOLENT HEAT.

Reproductions of designs, such as portraits and landscapes, have long existed on porcelain and enamel; we have numerous specimens of them on old crockery; but we believe it is the first time photographs have been bodily fixed on such substances by means of violent heat, estimated at 1,200 degrees Centigrade,

This process is due to M. Geymet, who not only makes no secret of it, but invites all who take an interest in photography to visit his laboratory, at No. 8, Rue Neuve des Augustins, at Paris, where he explains the different manipulations requisite for the success of the operation. We have before us a specimen of this new art in the portrait of a lady reproduced on the small signet part of a ring, and we have no hesitation in declaring that we never saw anything of the kind presenting a greater delicacy either of outline or of shade.—*Galignani.*

"SUNBEAMS IN BOTTLES."

POCKET sunshine is the latest novelty with which science has presented us. The art of extracting sunbeams from cucumbers has not been quite mastered, though we do not despair of witnessing that economical process; but something quite as useful, and almost as wonderful, awaits us. M. Xamben de Prades, of Saintes, is on his way to England with a cargo of sunbeams in bottles, of which he is anxious to present samples to the Royal Society. It is explained that he intends to avoid Paris, and come by way of La Rochelle; but the object of this is not very obvious, unless it is connected with the *douane,* or custom-house difficulties, and obviously the *savant* is likely to be exposed to some trouble on this score. Light is not liable to duty either in France or in England, but it would require some tact to convince the custom-house officers that M. de Prades' bottles did not contain spirits, or something which would bring them within the tariff. That a man should import, carefully corked and packed, empty bottles, would not be credible, while if any attempt were made at examination in the way of uncorking, the sunbeams would go off in a flash, and the value of the entire cargo would be dissipated into air.—*Photographic News.*

EXPLOSIVE SUBSTANCES.

NITROGLYCERINE and its compounds have by no means a first-rate reputation for safety, and the wisdom of recent legislation on the subject has been amply illustrated by the fearful accidents which have occurred within the last year or two. On January 26, 1870, a dynamite factory at Dunewald, near Cologne, exploded, by which 14 persons were blown to pieces. We believe that five other explosions of dynamite works occurred within the last year (1870)—namely, those of Krümmal, near Lauenberg, May 29; Waldenberg, in Upper Silesia, April 2; factory near Spandau, in Prussia, November 8; factory near Prague, November 6; factory at Benthen, near Königshutte, in Upper Silesia, November 17. Lithofracteur is merely dynamite in disguise, and we trust that its safety will be amply proved before the smallest change in the law is made in its favour.

Of all these explosive substances compressed gun-cotton is undoubtedly the cleanest, handiest, and safest. In addition to

its value as a mining agent, gun-cotton cartridges have been largely used by sportsmen during recent seasons, and have, on the whole, given much satisfaction. The comparative absence of smoke facilitates accurate shooting with the second barrel, and the longest day and heaviest bag still leave the shoulder free from that tenderness which often results from the "kicking" effects of gunpowder. This feebleness of recoil has led many to jump to the hasty conclusion that gun-cotton cartridges are deficient in hard-hitting qualities, and that their use is incompatible with good steady shooting. Careful trial, however, does not support this view. The old adage of a bad workman complaining of his tools is frequently applicable to the would-be sportsman, and it is probable that nine misses out of ten are really due, not to the badness of the cartridge, but to the fact of the gun not being held straight. It is easy to verify the hitting qualities of different cartridges, and we annex the results of a comparative experiment carried out within the last few days, in which gun-cotton and gunpowder cartridges were fired alternately, under identical circumstances, from a 12-bore central fire breech-loader. The object was to ascertain the number of hits or shot holes in a given space and the depth of penetration. The ammunition was taken from the current supply in a country house, and may be said to fairly represent ordinary quality, the gun-cotton cartridges being those of Messrs. Prentice. Each cartridge contained $1\frac{1}{8}$ oz. of No. 6 shot. The number of hits at 40 paces was recorded on a half sheet of the *Times*, and the depth of penetration, at 25 paces, given by firing at a *Bradshaw*, and counting the number of leaves perforated. Aim was taken at the centre of both objects, and the same barrel of the gun used throughout. The following table gives the results in detail:—

Nature of Ammunition	No. of hits per round on half-sheet of the *Times* at 40 paces.	No. of sheets of *Bradshaw* perforated at 25 paces.
Gunpowder (Eley's green cartridge)	34	82
" "	39	69
" "	25	73
Gunpowder (Eley's blue cartridge)	41	60
" "	58	78
Gun-cotton (Eley's green cartridge)	74	92
" "	64	90
" "	86	89
" "	68	62
" "	63	75

—*From the Times.*

ON WATER.

Professor Tyndall having arrived at the practical conclusion that Water, chemically and physically pure, is best adapted for the use of man, he concludes from it that it is therefore desirable to take whatever means may be necessary in order to obtain such water, or the nearest possible approximation to it. The proposition itself is, so far as "A Biologist" in the *Times* can judge, not proven. Mankind (if we except philosophers), and Nature herself, do not commonly deal with chemically pure substances. Chemically pure air—air that is without a trace of ammonia, carbonic acid, or water, is not to be found; and the one thing certain about it is, that if it were we could not live in it.

The writer remembers once to have heard a very distinguished chemist recommending the use of aerated bread on the ground that it must be more wholesome than other bread, because it consisted of pure flour and water and excluded yeast, which he appeared to look upon as a vehicle for organic matter of uncertain composition. It did not seem to occur to him that all mankind had been eating fermented bread for some thousands of years, that there was absolutely no ground for supposing that it did them any harm, and not even any proof that it was not better suited to their constitutions than the new bread which he recommended. Similarly in regard to water itself, pure water is never found in nature; and observation of the habits of the whole animal creation, including man himself, tends to show us that pure water is not necessary, nor even demonstrably desirable. The votaries of strict science seem sometimes to lose sight of the correlation which subsists between the inorganic and organic worlds; to forget that man, like other animals, is suited to his dwelling-place; and to think, consequently, that he must submit the world to a series of severe chemical operations before it is fit for him to live in.

The fact is that chymistry and physics, vast as are their recent achievements, are not yet in a position to deal with the delicate and complicated problems which biology presents to us; and any attempt to apply them to that purpose tends to delay rather than to hasten the time when we may hope that they will be so. Empiricism must reign for some time yet in sanitary and other practical matters; and to attempt to dethrone it prematurely by a violent assault will not advance by a single day the time at which scientific knowledge is destined to succeed it.

As regards the present matter, every sunbeam which enters a darkened room shows us how thick with solid impurities is the air we breathe, yet we do not on that account fear to breathe it. Professor Tyndall has now shown us that the same thing happens in the case of water, but this need not necessarily make us afraid to drink it. Not all foreign matters, nor even all foreign organic matters, are of necessity unwholesome. What we really know now is exactly what we knew before—viz., that

it is the deflements arising from man himself which are really dangerous, and that we should do better to employ our energies in keeping these completely away from our natural sources of supply than in looking out for new ones.

On this last subject, experience of a chalk district near London, in which the writer lately lived, leads him to question the "inexhaustible" quantity of its water supply, which the cutting down of woods, the drainage of land, and the making of railways, unaccompanied as these great changes are by any attempt at the storage of water, have a constant tendency to diminish.

ON THE CHEMICAL ASPECTS OF GLASS.

BY R. J. GRIFFITHS, LL.D.

THERE are four different kinds of Glass used in common life.

1. The ordinary window glass.
2. Bohemian glass.
3. Flint glass.
4. Common green bottle glass.

The chemical constitution of these various glasses differs in many important respects, but there is one point in which they are all alike—they are all compound silicates, that is to say, a silicate of an alkali is found united with a silicate of an alkaline earth. Why this is so will be easily seen from a consideration of the peculiar properties of these respective silicates. It is known that a silicate of an alkali—soda, for instance, is soluble in water, and does not assume a crystalline form, whereas, on the other hand, silicates of the alkaline earths *are* soluble in acids, and assume a crystalline form. It is found that a compound of these two silicates is insoluble in water and acids, neither does it crystallise, and when fused it is called a *glass*.

The composition of the various kinds of glass varies considerably. Silicates of baryta, potash, magnesia, alumina, lead, soda, and lime, are commonly employed. But few, if any, of these glasses can be regarded as compounds having a definite chemical composition, and the proportions of their ingredients also vary considerably. Crown glass, Bohemian glass, mirror plate, and flint glass are the most frequently occurring kinds.

The well-known Bohemian glass is composed chiefly of silicates of potash and lime, together with sand, manganese, dioxide or pyvolusite, and "cullet," which consists of broken glass of the same kind. This glass is peculiarly useful in the laboratory in the formation of tubes, which cannot be fused except with extreme difficulty. The beautiful ornaments made with this glass contain (in addition to the preceding constituents) silicate of alumina.

When it is necessary to prepare the finer specimens of glass, potash is used instead of soda, as it is found that soda imparts a peculiar tinge which is not the case with potash. This tinge probably arises from the presence of some impurities.

Ordinary window and plate glass consists chiefly of silicates of soda and lime, and it is very fusible. In the selection of the materials for the manufacture of the finer kinds of glass, great care is exercised in the selection of the materials, and it is also necessary to mix them with great exactness. If, for example, an excess of lime be used in the manufacture of window glass, it will render it milky when cooled, although perfectly transparent when hot. Instead of carbonate of soda the cheaper sulphate is frequently employed, the sulphuric acid contained in this latter compound being expelled at a high temperature by the silicic acid present, and if some charcoal be present this decomposition is much facilitated.

A curious fact is connected with the ordinary *bottle-glass*. If it be cooled slowly it may lose its vitreous properties, and be changed into what is called Reaumur's porcelain, an opaque and milk-white substance much resembling porcelain in appearance. To produce this change the glass may be imbedded in sand and heated so as to soften it, but not sufficiently to fuse. If it then be cooled very slowly it will be found to resemble porcelain in appearance, and it is considerably harder than the original glass. This interesting change is probably owing to the partial separation of some of the silicates, especially those of lime and alumina and their assumption of a crystalline form. This may frequently be noticed in glass-works. When pots are allowed to cool with great slowness, small, rounded, irregular-shaped opaque crystals are observed. When glass has been thus deprived of its vitreous aspect, it may be reconverted into its original form by fusion. Some interesting experiments were made by Pelcure in 1855 upon the devitrification of glass.

Flint glass contains lead oxide (red lead, not the ordinary litharge), which increases its fusibility, specific gravity, and lustre, and in addition fine white sand is used. Common vessels are made of flint glass, but the glass articles used in the laboratory contain soda and lime.

CHEMISTRY OF SUGAR AND STARCH.

Professor Odling has shown by experiments the conversion of Starch into Grape Sugar by boiling the starch for a few minutes with dilute acids—a most remarkable instance of the metamorphosis of one organic substance into another. The sugar, when tested, was shown to possess all the properties of the sugar formed by nature in fruits.

Natural History.

ZOOLOGY.

MAN AND THE APE.

MR. C. STANILAND WAKE has read to the British Association a paper, in which he referred to the agreement in physical structure of Man and the Ape, and to the Fact that the latter possessed the power of reasoning, with all the faculties necessary for its due exercise. It is incorrect to affirm that man has no mental faculty other than what the ape possesses. He has a spiritual insight or power of reflection, which enables him to distinguish qualities and to separate them as objects of thought from the things to which they belong. All language is in some sense the result of such a process, and its exercise by even the most uncivilised peoples is shown in their having words denoting colours. The possession by man of the faculty of insight or reflection is accompanied by a relative physical superiority. The human brain of man is much larger than that of the ape, and he has also a more refined nervous structure, with a naked skin. The author observed that the size of the brain was the only physical fact absolutely necessary to be accounted for, and this could not be done by the hypothesis of natural selection. Mr. Wallace's reference. on the other hand, to a creative will really undermines Mr. Darwin's whole hypothesis. After referring to the theories of Mr. Murphy and Hoeckel, the author stated that the only way to explain man's origin, consistently with his physical and mental connection with the ape, is to suppose that nature is an organic whole, and that man is the necessary result of its evolution. While, therefore, man is derived from the ape, as supposed by Mr. Darwin, it is under conditions very different from those his hypothesis requires. According to this, the appearance of man on the earth must have been in a certain sense accidental; while, according to the author's view, organic nature could only have been evolved in the direction of man, who is the necessary result of such evolution, and a perfect epitome of nature itself.

OUR ANCESTORS.

DR. CHARLES RATH, of S. Paulo, writes on the subject of the Antiquity of Human Life in Brazil, as evidenced in the numerous shell deposits found on rocky islets and islands, in the centres or bottoms of which are always human bones, while near the deposits are numbers of stone weapons and tools, such as axe heads, lance points, arrow heads, wedges, &c. The deposits are of two kinds, one of oyster shells and the other of mussels (*Tellina antediluvium*), are in general 40 ft. to 60 ft. and upwards

above the present sea level, and have a thickness of 7 ft. to 12 ft., and a circumference of 15 ft. to 150 ft. Some are on the top of hills. The position of the bones indicates that the body was interred in the attitude of a fœtus; and near it were placed the arms and pertainings of the deceased, together with food, consisting of large cooked fishes, game either entire, or in parts, &c., a custom still observed by the Botocudos. The bones have lost their gelatine, and are very light and brittle. The facial angle, taken by Owen's method, is 66 deg. The skulls found by Dr. Rath in the limestone caves of San Paulo, by Dr. Lund in the caves of Minas Goraes, and in the ancient sepulchres of Peru, have the same facial angle as those of some of the tribes included in Brazil under the common denomination of Botocudos, while that of other tribes varies from 67 to 68 deg. That of the European is 80 deg. The shell deposits of Brazil resemble those found in other parts of the new and old world, and the arms and tools are also similar, including the so-called thunder stones. Besides the shell deposits on the coast, there are mounds of earth, or of earth and stones, or stones alone, in the interior of the country, 7 ft. to 44 ft. high, in the centre of which are similar stone articles, together with pieces of crystal, ornaments of coral and Jatahy resin, all of which are also found in the shell heaps. Dr. Rath says the description of the shell heaps which Captain Burton gives is erroneous in many respects. He says that the nature of the diluvian deposits covering the shell heaps, and of the shells themselves, testifies to the fossil state and high antiquity of those remains of human life in Brazil. Besides the shell heaps due to human agency, there is a third kind, consisting of broken shells, sand, and earth, evidently the result of natural agencies. All kinds are found now always 30 ft. to 45 ft. above the waters of the rivers, and inland, where the waves had least force.—*Anglo-Brazilian Times.*

THE ADAMITES.

Mr. C. S. Wake has read to the Anthropological Society a paper, the object of which is to show, by reference to evidence extraneous to the Hebrew Scriptures, what peoples are entitled to be classed as Adamites. The name of the primitive race from which the Chaldeans sprung—the Akkad—proves that they must thus be classed. Akkad would seem to mean "sons of Ad;" the first syllable of the word being the same as the Gaelic Mach or Ach. The first Babylonian dynasty of Berosus was Median; and Sir Henry Rawlinson says that the name by which the Medes are first noticed on the Assyrian monuments is Mad. This people, the initial letter of whose name may be treated as a prefix, were doubtless the primitive stock from which the Akk-Ad were derived. The Medes had also the distinctive title of Már; and many of the Aryan peoples appear to have retained a remembrance of the traditional Ad. The first

part of the Parsee work known as *The Desatir* is called *The Book of the Great Abad,* i.e. Father Ad. The Puranas of the Hindus refer to the legendary king, It or Ait, who is supposed to be the same as the Greek Ætus. The primitive Celtic race of Western Europe was called Gaidal, i.e. the progeny of Gaid or Aid, who may be identified with Dis, the mythical ancestor, according to Cæsar, of the Gauls. Dis (the Greek Hades) was also "Lord of the Dead" among the Chaldeans, and may well, therefore, have been the same as the legendary ancestor Ad. Among Hamitic peoples, the original Arab stock trace their origin to Father Ad, who is probably referred to also in the name of the Egyptian deity, At-um. The name of the legendary ancestor of the Adamites may be traced in the names of the deities of Turanian and American peoples, and also among the Polynesian islanders. Dividing all the races of mankind, according to the classification of Retzius, into brachycephali and dolichocephali, Mr. Wake asserted that Ad was the legendary ancestor of the former, the Adamites, therefore, embracing all the actually brachycephalic peoples, and those whose brachycephalism has been lost by intermixture with the long-headed stock.

JOINED TWINS.

The numerous sightseers who are attracted by any freak of nature have been gratified by the exhibition of a pair of Joined Twins, whose union is even more complete than that of the Siamese brothers. The subjects of this malformation are girls, who are united, not by an intervening band as in the case of Chang and Eng, but by the absolute coalescence of the two spinal columns in their lower portions. The union appears to extend in some degree to the circulatory and nervous systems, so that each twin feels a touch on the legs of the other. It may, indeed, be said that the girls are essentially two above the hips and essentially one below. They were originally united back to back, but their bones yielded during infancy and childhood to their struggles against the inconveniences of this relation, and they are now inclined to one another at a slight angle. They were born in North Carolina in 1851 of a slave mother, and were for a short time in England in 1855. They are now spoken of by those in charge of them as one individual, although the heads and busts are known respectively as Millie and Chrissie. There can be no doubt that their lives are inseparably blended, and that no question about the severance of the union could ever arise in their case. Millie and Chrissie are short, but otherwise well developed. Their mother was a full-blooded negress, their father a mulatto; and their colour and features are such as this descent would naturally produce. They have been well educated, and appear very happy, lively, and good tempered. They sing duets and dance gracefully, the four legs moving together with perfect rhythm; and they talk with much

intelligence, each head asserting its own individuality, and saying "I," rather than "we." The Siamese twins, in their old age, had, it will be remembered, a mournful and suffering look, which rendered a visit to them almost painful. Millie and Chrissie, on the contrary, laugh and talk and roll their eyes about after the fashion of their race, in such a manner that those who see them will hardly feel called upon to bestow sympathy on an union which its subjects manifestly do not consider a misfortune. Opinions will differ about the propriety of exhibiting malformations of any kind, but in this case the manifest contentment of the girls takes away the element of repulsiveness from the show. They were accompanied by the Nova Scotian giantess, Miss Swan, who was with the Siamese twins, and also by a Kentucky giant (Captain Bates) of vast proportions and very tolerable symmetry.—*Times.*

THE RED-BLOOD CORPUSCLES.

IN the *Quarterly Journal of Microscopical Science*, Mr. Ray Lankester, in a paper "On the Red-Blood Corpuscle," describes the action of a number of reagents on this structure. Of practical importance is the suggestion that physicians should make use of the vapour of osmic acid—as first proposed by Schweigger-Seidel—to preserve blood-corpuscles unchanged for microscopic examination, in studying the various phases of a disease, and in comparing various diseases. It is the want of a method of manipulation which has hitherto caused physicians so greatly to neglect the examination of the blood in clinical study.

THE AMERICAN DEEP-SEA EXPLORING EXPEDITION.

THE object of this Expedition is Deep-Sea Dredging and scientific researches, respecting which the *Boston Advertiser* publishes the following interesting details:—"The management of the scientific matters is in the hands of Professor Agassiz, who in the sixty-fifth year of his age starts out on an expedition to the antipodes in the pure love of science. He will devote himself principally to the department of natural history. Count Pourtalès, of the Coast Survey, who will have charge of the dredging, has had more experience than any other man living in such operations. The course of the expedition will be straight for the West Indies, and there a stop of some length will be made for the purpose of testing the apparatus, as it is impossible to test it before starting on account of the roughness of the water in the vicinity of this harbour. The testing of the apparatus will be made near St. Thomas, after which the expedition will go outside the West India Islands to ascertain how the great current that comes from Africa enters the Gulf of Mexico, and how the Gulf Stream is supplied. Then the *Hassler* will move to the eastward, seeking the greatest depths of the Atlantic Ocean. She will then

go to Rio Janeiro for coal, and thence to the east coast of Patagonia and the Falkland Islands, where another series of investigations will be made, especially with a view of studying the currents that come from the South Pole into the Atlantic. The *Hassler* will then pass through the Straits of Magellan into the Pacific, exploring the glacial phenomena in the Straits on the way, and then through the Archipelago of Chiloe, striking out into the broad ocean towards the island of San Juan Fernandez. This will be during the month of February, and about midsummer in that latitude. The course of the expedition will be next to Valparaiso, crossing the great current which flows north along the west coast of South America Here it will be sought to ascertain whether this current is the counterpart of the current which flows southward along our coast. The expedition will then proceed to the Galapagos Islands, and then to the continent, probably to Acapulco, although the point is not fixed, and will be determined by the progress of the expedition. Next summer will be devoted to the exploration of our own coast from Panama to San Francisco, and a visit will be made to the islands to the west of Lower California, which have never yet been explored. The voyage will occupy about ten months, and may extend as far north as Puget's Sound, perhaps even beyond there. The party will return across the continent."

AN AMERICAN FOX.

The Rev. Charles D. Nott, of St. Louis, sends to the *New York Independent* a story suggested by the remark of a learned metaphysician that he had "doubts whether the lower animals can abstract, whether they can generalise." "A former pastor of mine," says Mr. Nott, told me the following:—When a boy, he had a fox, which, I regret to say, bore the reputation of possessing far more brain than personal piety. This fox was kept in the yard in a sort of raised den nicely sodded over, and was confined by a chain that allowed him quite a generous circumference. One evening in the fall, the farm waggon, returning from the field with a load of corn, passed near the den, and by chance dropped an ear where the fox could reach it. He was seen to spring out, seize the corn, and carry it quickly back into the den. What he wanted with it was a mystery, as corn formed no part of the gentleman's diet. The next morning, however, the mystery was solved, for the fox was observed out of his den, and considerably within the length of his chain, nibbling off some of the corn, and scattering it about in full view of the poultry, after which he took the remainder back into the den and waited events. Sure enough the chickens came; and while eating out sprang the fox, nabbed his man, and quietly took his breakfast in his back parlour. Now it seems to me that this is pretty 'good generalising.' The fox may not have reasoned upon the most sublime theme imaginable. I regret to say he did not; and for that

matter neither does Colonel James Fisk, jun. But if he didn't evolve that chicken out of the depths of his own consciousness, then there is no such thing as logic."

BIRTH OF A HIPPOPOTAMUS IN THE ZOOLOGICAL SOCIETY'S GARDENS.

MR. FRANK BUCKLAND, writing to *Land and Water*, says:—"On Tuesday morning, Jan. 9, 1872, Mr. Bartlett was kind enough to inform me that a little hippopotamus had been born. Of course I went to the gardens at once. On looking through the window of the house where the hippopotamus keeper resides, we could easily see the mother and baby; the scene was very much the same as that which I described when the last baby hippopotamus was born. The mother lay in the corner furthest away from the window, the young one lay close to her, the nose of the mother was close to the nose of the infant. Everything was painfully quiet, and the only sound was the chirping of the sparrows; the sparrows seemed to chirp louder in the hippopotamus house than anywhere else. I understand there was no difficulty about the birth, and that the mother did not sweat blood as on the previous occasion. The little animal, as Mr. Bartlett informed me, had not been seen to suck, although the mother had plenty of milk. An attempt had been made to get the little thing away directly it was born, but the mother was so savage that it was thought best by Dr. Sclater and Mr. Bartlett to leave matters alone. As far as I could make out, through an opera-glass, the little one is as near as possible the same size as its brother, which was born February 21, 1871, and died in three days. It seems surprisingly strange that the instinct of the mother was not sufficient to induce the young one to suck, and it seems almost contrary to the rule of nature that the young one did not know where to seek its food. Both mother and child had been in the water, and the young one could swim as well as its mother. Two milch goats had been provided in case they could have got the young one away from its mother. The real Fact is we do not know what the real habits of the hippopotami may be when they bring forth their young in a state of nature, and this shows the value of the doctrine I have always preached—namely, how much more interesting and important it is for the sake of zoological science that travellers should not continually shoot, shoot. Now, if some of our African travellers—and surely there are plenty of gentlemen now in London who have been in countries where hippopotami abound—would have taken the trouble to inquire of the natives, or observe themselves, how the young hippopotami are managed by their mother, they might have been able to afford Dr. Sclater and Mr. Bartlett such valuable information as would have enabled them to preserve the life of such a little animal so valuable to the Society. On Thursday morning I went again,

and found, alas! that the little Umzimvooboo, as the Africans call the hippopotamus, had died at 6 o'clock on Wednesday night, at the age of 84 hours. It was in the dissecting-room, and an artist was making a drawing of it for the *Illustrated London News*. Its total length from tip of nose to end of tail was 3 ft. 9 in.; the head 10 in. long, the tail 5½ in. The skin is very much corrugated, and seems covered with a glass-like varnish. It is very pink about the mouth and lower jaws. The hoofs are dark chocolate, the legs and lower portion of the body the colour of the section of a piece of indiarubber. Mr. Bartlett, with his usual energy and perseverance, managed to get the young one away from its mother, and it sucked down a pint and a half of goat's milk before it died. They managed to drive the mother into her tank of water by squirting water into her face with a powerful garden engine. The moment she entered the bath they slammed the gate, and then stole the young one. I understand that this rare specimen of a sucking Behemoth is to be sent to Oxford for dissection. The black flag will be hoisted in all zoological establishments."

AMERICAN BITTERN.

An American Bittern (*Ardea minor*, Wilson) has been shot at Woodhill, near Liskeard, in Cornwall. This bird had only been found in Britain on twelve previous occasions.

THE GREAT BUSTARD.

The Rev. F. O. Morris writes to the *Times*, Feb. 1:—"I have this morning received from the Rev. Edward Durnford, Rector of Monxton, near Andover, the following extract from the *Salisbury Journal*. I should imagine that the birds were of the same flock spoken of as having been seen in Dorsetshire.

"'A great Bustard (*Otis tarda*) was shot on Monday last on the Maddington Manor Farm, by a birdkeeper, named Stephen Smith, in the employment of Mr E. Lywood. The gun was loaded with a 'marble,' and the shot was a long one, 132 yards; the bird, which was in company with two others, had its wing broken, and fell in an oblique direction with great violence to the ground, a distance of about 20 yards. One of the survivors, shortly afterwards, wheeled round the spot, passing within 15 yards of Smith, evidently looking for its companion. Mr. Lywood brought the bird to Salisbury and very kindly presented it to the Salisbury and South Wilts Museum; it is a female, weighing 7¼ lb. only; the crop was quite empty, and the bird was not in good condition, although in beautiful plumage. It measures 31 inches from the beak to the end of the tail, and 62 inches from tip to tip of the wings. Something has been said about the difficulty experienced by the bustard in taking wing, but Mr. Lywood observed that they rose with ease from the ground,

merely stretching the neck upward before taking flight, their flight being not unlike that of the curlew. It is reported that four bustards have been shot recently in Cornwall, and that others have been seen in Dorsetshire."

These great birds used formerly to breed on the Wolds near here, and the late Mr. Henry Woodall, of North Dalton, once told me that his father-in-law had on one occasion shot two near there with a right and left shot.

The latest appearances of the great bustard in Yorkshire that I have heard of were, one, a female, in Rufforth, near York, on the 22nd of February, 1861 (just ten years since the great storm of that date of which we have this year had, and are still having, the counterpart). It had been seen there since the 24th of the previous December. The other was picked up in the sea off Burlington Quay, "found drowned," by some boatmen, in November, 1864, also, as you may remember, a winter of unusual severity."

The Rev. Mr Morris writes further, on February 8:

"I had promised a brother magistrate to attend our Petty Sessions at Pocklington, and the first business happening to be an Excise game case, we had occasion to refer to some law books on a difficult point which occurred, and this led me to notice—which I had never been aware of before—that under the statute 1 and 2 William IV., cap. 32, sec. 2, bustards are included as 'game,' with pheasants, partridges, grouse, heath or moor game, and blackcock, &c.

"It appears, therefore, that the person who shot the one in Wiltshire the other day had no right to shoot it unless he had a game license, and is liable still to be summoned for the offence. The 'season' for their preservation differs from that fixed for the protection of other game, extending only from the 1st of March to the 1st of September (viz, 'between,' not 'on or between,' these dates).

"The above-mentioned Fact may not be generally known or noticed, but I think it of importance that it should be, for, as I incidentally mentioned in my letter in the *Times* last week, these great birds used formerly to breed on our Yorkshire Wolds, and that not so very long ago. So they did also in Norfolk, and even so late as 1832 three female birds had nests and eggs at Great Massingham. They are twice mentioned in the Household and Privy Purse Accounts of the L'Estranges of Hunstanton, kept in the reign of Henry VIII. The Rev. Leonard Jenyns, in his *Observations on the Ornithology of Cambridgeshire*, published in 1821, mentions that they were formerly plentiful in that county, as on Newmarket Heath, &c. Doubtless, also, the like was the case on Salisbury Plain, in Wiltshire, and on the Dorsetshire Downs.

"We may feel sure, then, that if the protection which the law, it seems, at present extends over them were known and enforced, the great bustard would again increase and multiply like any other game birds; and as the one shot recently in Wilt-

shire weighed 19 lb., even on that score they ought to be rigidly protected.

"The capercaillie, our largest game bird, weighs but from 9 lb. or 10 lb. to 13 lb., and only in extreme instances as much as 17 lb. or upwards, and the pheasant only from 2½ lb. to 3 lb. or 4 lb. The heaviest of which I have any notice are 4 lb. 6 oz., 4 lb. 8 oz., and 4 lb. 9 oz.

"Before I knew that the above was the law I could not but in some degree excuse the ignorant person who shot the bustard lately recorded, for I thought it a very different case from the wanton destruction of small birds of no use to any one, to which I am truly glad to say the gun tax has to a great extent so happily put a stop. The Chancellor of the Exchequer is the best friend our British birds have had for many a long day.

"Otherwise, the shooting of any chance straggler that visits our shores is a grievous and lamentable thing, to be regretted by every humane person, and as far as possible put a stop to. The letters on the subject you have been good enough to publish, not only from myself but from so many other gentlemen, have beyond all doubt done much in this direction."

MARINE MONSTERS.

CAPTAIN DAVIS has related his being lately attacked by the *Octopus vulgaris*, or eight-armed cuttle, which, "it is said, will attack a man, and by fixing itself to his body, by suction, so that it cannot be removed, destroy him."—(*Life in Normandy*.)

Lt.-Colonel Stuart Wortley relates that he has seen an octopus behave in a manner somewhat analogous to that described by Captain Davis. "The octopus frequently remains at low water in crevices under rocks perfectly dry, and if extracted thence and thrown into a pool of water will, after swimming round two or three times to seek shelter, leave the water and proceed overland to seek such shelter among rocks as he may deem advisable. If interrupted in his progress I have seen one strike at and seize a stick viciously and with considerable power. I have for years made a study of marine life, on the shore and in aquaria, and have seen the octopus behave in this manner—not once, but a dozen times The behaviour of the sickly specimens in the Crystal Palace aquarium (one was lying dead in a corner when I last visited the aquarium) would give little clue to their motions when in a healthy and wild state."

The aquarium at the Crystal Palace contains, with many other very interesting objects, several specimens of the poulpe, or eight-armed cuttle, *Octopus vulgaris*, obtained from the sea on the Devonshire and North Wales coasts. This is the animal which has been made famous under the names of devil-fish or man-sucker, by the sensational descriptions of it in Victor Hugo's Guernsey romance, *Toilers of the Sea*, and in other works of imaginative writers. But as Mr. W. A. Lloyd, the

superintendent of the aquarium, remarks in his protest against such exaggerations, "It is but wanton ignorance and vulgarity to call the octopus a 'devil-fish,' when it has about it nothing diabolical or fishlike. It is simply a mollusc, very high up in the scale of the mollusca, with its viscera and other internal organs contained in an egglike sac, which is surmounted by a pair of prominent and sometimes staring eyes placed on protuberances; and below, set on obliquely, is a series of eight stout, radiating, tapering arms, provided in all with about 2,000 round projecting suckers, on the lower surfaces of the arms. Such a creature is in itself sufficiently wonderful without being invested with fictitious attributes." It is a fact, however, says Mr. Lloyd, that these cuttles will, if alarmed, catch hold of a man within their reach in the water, though they cannot grasp him out of the water. "The specimens here under my care will, if I permit them, as I have done, firmly affix themselves to my submerged bare hand and arm by the crowds of sucking discs beneath each of their long flexible legs, arms, or tentacles, and then they will draw themselves on till they get into a convenient position, and give a severe bite with their hard, horny pair of beaks or mandibles (not unlike those of a parrot), which are placed below, in the centre of the body, at the point whence the legs or arms radiate, but they soon leave go and drop off when I raise them above the water's surface. There are no cuttles in Sark, where Victor Hugo places his narrative, or elsewhere in Britain, so large that even a child could not easily kill or disable one of them at one grasp or kick. On the other hand, if an enormous hungry cuttle in the tropics, with arms measuring, as they sometimes do, from five to fifteen feet long, provided with thousands of suckers, each nearly an inch in diameter, and additionally provided, as many foreign species are, with a strong and sharp hook in the centre of each, in order to take firmer hold, armed also with a terribly crushing pair of beak-like jaws—should such a creature encounter a swimming man it would go hard with the man, without any spitefulness on the part of the cuttle."

It seems probable, on the whole, that the common dread of these creatures, among the seafaring people of the Channel shores, and in the south of Europe, is founded upon some instances of persons being drowned, or put in danger of drowning, by entanglement with their long pliant arms. The eyes are blank and expressionless, and are furnished each with a pair of greyish lids, one closing downwards from above and the other upwards from below, till they meet at the centre of the pupil. "At night, or in much shade," says Mr. Lloyd, "the eye is wholly uncovered, but in light the lids are separated according to the amount of illumination. If it be considerable, the separation is such as only to leave a very narrow horizontal slit for the creature's vision; but if very strong, their edges are brought into complete contact. These motions of the lids have not the

instantaneous character of the lid of the human eye, but are slow enough to be seen. The manner in which the eyelids of the octopus constantly vary in distance from each other when the creature moves about, and thus varies the amount of the shade through which it passes, is most interesting to witness. For instance, as it begins to enter the shadow of an overhanging rock in the Crystal Palace aquarium, the lids gradually separate and expose the eye beneath them, and they as gradually close again as the animal emerges into light." This very interesting account is quoted from the *Illustrated London News* for December 2, 1871, where the octopus is engraved.

SNAKE BITES.

Two additional cases in Australia have come under notice illustrating the efficacy of Professor Halford's remedy for Snake Bite. The first occurred on the Bass River, on the 1st of November, at about 1 P.M., when a son of Mr. Patrick Guinlivan, aged 11 years, was bitten just above the ankle by a snake. The punctures of the two poison fangs were distinctly visible with a little blood flowing from them. A ligature was applied, and about half a tumbler of strong spirits given in two doses. The symptoms increasing in severity, a piece of skin was removed from over one of the most prominent veins at the bend of the elbow, the point of the syringe carefully introduced into the vein, and about ten minims of prepared ammonia injected. The relief was almost instantaneous. Some time after, the foot being very painful below the ligature, this was removed, and additional poison entering the circulation, the worst symptoms of snake-poisoning returned, viz., total loss of power over the legs, cold clammy skin, and almost imperceptible breathing, while an occasional fluttering was all that could be felt of the pulse. Ten more minims were injected into the same vein. In two minutes the pulse could be again detected, a slight improvement set in, and by 7 o'clock in the evening the boy was well, and laughing as heartily as anyone could wish. The other case occurred in Tasmania, and was reported in the *Launceston Examiner* of the 10th of November. A shepherd at Waterhouse was severely bitten just below the knee by a large snake. All the symptoms of snake-poisoning set in, but the remedy was applied, and the man speedily recovered He described the sensation caused by the injection of the ammonia as that of an electric shock passing through his frame.—*Melbourne Argus.*

HERCULES AND THE HYDRA.

MR. FRANK BUCKLAND, writing in *Land and Water*, says:—"In September, 1863, there was a large living Octopus at the Zoological Gardens, Regent's Park. While making an experiment to see if this animal possessed any electric powers, an idea

suddenly struck me that the hydra which Hercules killed was simply a huge Octopus, or, as they call him at Folkestone, a 'man-sucker.' An author who wrote in 1868 thus described the hydra:—'A monstrous dragon with whom Hercules strove, and, as he struck off one head, or tentation, so two or three others rose continuously in the room thereof.' This is just what would happen if a man fought with an Octopus, for when the conqueror cut off one arm or tentation—mark the word—the Octopus would put out another, in its turn to be severed. My idea of Hercules' hydra being an Octopus was subsequently strengthened by the following letter which I received from the late Mr. Pentland:—"I have seen a letter from you in which you put forward the theory that the dread hydra which Hercules killed was a great 'man-sucker.' I can fully confirm your view from an examination of several Roman terra-cottas in the Campagna and Vatican Museums, where the demigod is represented slaying an immense Octopus, which is very correctly represented, although sometimes with more or fewer arms than in the great cephalopod. I think you might see representations of these ornamental tiles in Campagna's works on the terra-cottas of his collection, which will be found in the library of the British Museum. The nearest representation of the living Octopus is in the Gregorian Museum at the Vatican, where it forms one of a series of the labours of Hercules, and is probably of the time of the Antonines. You will see these terra-cottas noticed in Murray's *Hand-book of Rome*.'"

EELS IN WATER PIPES.

The pollution of our drinking water (the *Lancet* remarks) is of much more complex origin than is generally known. Before entering the various channels of distribution, the water, as it leaves the reservoir, passes through a kind of sieve, which is thought to keep back non-drinkable ingredients of the grosser sort, such as straws or twigs—to say nothing of drowned kittens and puppies which will sometimes find their way into these handy receptacles. The meshes of the sieve, however, are by no means so fine as to exclude infantine eels, which thread the barrier, descend into the channels of distribution, and finally enter the water pipes. By this time, thanks to the nutritious qualities of the liquid with which London slakes its thirst, the enterprising apodian has developed to a considerable bulk, until the pipe becomes such a very tight fit that further progress is impracticable. There it sticks, a case of true embolism, either till the impeded water above it causes the pipe to burst, or till death by pressure leaves it to decompose and taint the drinking supply of some household. This occurrence is much less rare than is popularly suspected. We have instances within our knowledge in which the gardener of a suburban villa has cut through a pipe and the head of an immense eel at the same time—thereby disclosing to the puzzled householder the cause of the leakage of water above the point of obstruction.

EYELESS FISHES.

An American paper, the *Montrose Republican*, contains the following interesting paragraph on subterranean lakes and eyeless fishes, seeming to show that the eyeless fish is a "development" consequent on change of circumstance. It is well known that great trouble and expense have been caused by the sinking of a portion of the track of the new Jefferson Railroad where it crosses a swamp in Ararat township in this county. It has been found that under the swamp is a subterranean pond of several acres in extent, and of considerable depth. This pond is covered by about six feet in depth of black earth, which supports a heavy growth of woods. The trees are mostly soft maple, pine, hemlock, and birch, many of them ranging from six inches to three feet in diameter. Last fall it was discovered that this subterranean pond contained many fish of the kind usually found in this part of the country—pickerel and "shiners" among others—but all without eyes! In the darkness of their subterranean abode they have no use for the organ of vision. The Ball Pond, about a mile and a half distant, is now "growing over." A considerable part of it has now become subterranean within the last twenty years, and probably before many years it will be entirely covered like the other. This pond is about twenty acres in extent. For some distance from the shore it is filled with a dense growth of water lilies, and these, no doubt, furnish the foundation of which the superstructure of earth is commenced.

MIMETIC RESEMBLANCE BETWEEN TWO NORTH AMERICAN LIBELLULIDÆ.

Mr. M'Lachlan has brought before the notice of the Entomological Society an instance of Mimetic Resemblance between two North American Libellulidæ. The insects in question were known as *Libellula pulchella*, Drury, and *Plathemis trimaculate*, De Gear, belonging to different groups. In the former, the sexes were nearly similar in appearance, in the latter, they were dissimilar, and the female almost precisely resembled either sex of *L. pulchella*. Both were common North American species. During the discussion that followed, the question was raised of the liability or non-liability of dragon-flies to the attacks of birds. Mr. F. Smith had seen swallows devouring Agrions, and Mr. Briggs had observed a combat in the streets of London between a sparrow and a large dragon-fly, in which the latter overcame the attacks of the aggressor. It was recommended that American entomologists should observe the habits of these two species, and suggest a reason for the close mimicry existing.

FORMIA HERCULANEA.

At the Entomological Society, with reference to Prof. Westwood's exhibition of *Formia herculanea*, found in the crop of a

great black woodpecker, said to have been shot near Oxford, Mr. Dunning remarked that, according to information he had received, several examples (presumably of foreign origin) of this bird were exposed for sale in the London markets at the precise time one was said to have occurred near Oxford. Prof. Westwood had information from Messrs. Robertson and Jackson that it occurred in Devonshire, the former gentleman having repeatedly seen it at Clovelly. Mr. F. Smith was informed that thirty examples had been recorded as British, and that one in particular had been shot by the grandfather of the present Lord Derby. Mr. J. Weir reiterated his belief in the species not being British; and Mr. Bond said that every recorded instance of its occurrence had been traced, and found to be fictitious, excepting Lord Derby's specimen, concerning which much doubt existed. Mr. E. Sheppard could not reconcile the occurrence of a gigantic species of ant, not hitherto known as British, in the crop of a bird the origin of which was open to doubt. with the idea of the former being an addition to the British Fauna. Mr. M'Lachlan suggested that Prof. Westwood should visit the locality in which the bird was said to have been shot, and search for the ant. The discussion ended by Prof. Westwood promising to furnish further evidence.

ANTS AT MENTONE.

Mr. F. Smith has read to the Entomological Society a letter from Mr. J. T. Moggridge, with reference to the habits of certain species of Ants belonging to the genus Aphenogastes, as observed at Mentone at the end of October and beginning of November. Mr. Moggridge affirmed that these ants harvested the seeds of various plants in chambers, sometimes excavated in solid rock. He had seen them busily engaged in conveying the seeds into those chambers, and found that, in most cases, they gnawed off the radicle to prevent germination; but he had also observed sprouted seeds being brought out again, as apparently unsuited for store purposes. Many of these seeds had their contents extracted through a hole on one side, and though he had not actually seen the ants feeding upon them, he was inclined to believe that the stores were made for the purpose of supplying food.

EGYPTIAN WASP.

Mr. Smith has mentioned to the Entomological Society that a common Egyptian Wasp, *Rhynchium brunneum*, obliterated by its nest the inscriptions on the ancient monuments in that country; and he exhibited an example of the same wasp which had been found in the folds of the covering of a mummy, showing that the species had inhabited Egypt for many ages. Mr. Smith further alluded to a passage in Pepys' *Diary*, dated in May 1665, in which the writer narrated how he had seen a glass

hive where the bees could be seen at work, proving that observatory hives were not a modern invention.

VIVISECTION IN ENGLAND.

It is to be feared that frogs are too sensitive for their own happiness. In the *Lancet* appears a report of a lecture on Experimental Physiology by William Rutherford, M.D., F.R.S.E., during the delivery of which he exhibited certain interesting experiments. "Observe this frog," said the lecturer; "it is regarding our manœuvres with a somewhat lively air. Now and then it gives a jump. What the precise object of its leaps may be I dare not pretend to say; but probably it regards us with some apprehension and desires to escape." The frog had some slight reason for apprehension, for the lecturer proceeded:—"I touch one of its toes, and you see it resents the molestation in a very decided manner. Why does it so struggle to get away when I pinch its toes? Doubtless you will say because it feels the pinch and would rather not have it repeated. I now behead the animal with the aid of a sharp chisel. . . . . The headless trunk lies as though it were dead. The spinal cord seems to be suffering from shock. Probably, however, it will soon recover from this. . . . . Observe that the animal has now spontaneously drawn up its legs and arms, and it is sitting with its neck erect just as if it had not lost its head at all. I pinch its toes, and you see the leg is at once thrust out as if to spurn away the offending instrument. Does it still feel, and is the motion still the result of the volition?" That the frog did feel there appears to be no doubt, for Mr. Rutherford related that, having once decapitated a frog, the animal suddenly bounded from the table. He then returned to the animal immediately under observation, pinched its foot again, the frog again "resenting the stimulation." He then thrust a needle down the spiral cord. "The limbs are now flaccid. . . . . We may wait as long as we please, but a pinch of the toes will never again cause the limbs of this animal to move." This frog being done for, the lecturer continued:—"I take another frog. In this case I open the cranium and remove the brain and medulla oblongata. . . . I thrust a pin through the nose and hang the animal thereby to a support so that it can move its pendant legs without any difficulty. . . I gently pinch the toes. . . . . The leg of the same side is pulled up. . . . . I pinch the same toes more severely. . . . . Both legs are thrown into motion." Having thus clearly proved that the wretched animal could suffer acutely, Mr. Rutherford observed:—"The cutaneous nerves of the frog are extremely sensitive to acids; so I put a drop of acetic acid on the outside of one knee. This, you see, gives rise to most violent movements both of arms and legs, and notice particularly that the animal is using the toes of the leg on the same side for the purpose of rubbing the irritated spot. . . . I dip the whole

animal into water in order to wash away the acid, and now it is all at rest again. I put a drop of acid on the skin over the lumber region of the spine. . . . Both feet are instantly raised to the irritated spot. The animal is able to localise the seat of irritation. . . . I wash the acid from the back, and I amputate one of the feet at the ankle. . . . I apply a drop of acid over the knee of the footless leg. . . . . Again the animal turns the leg towards the knee as if to reach the irritated spot with the toes; these, however, are not now available. But watch the other foot. The foot of the other leg is now being used to rub away the acid. The animal, finding that the object is not accomplished with the foot of the same side, uses the other one." These experiments clearly demonstrate that frogs, with or without heads, are not only very sensitive, but very intelligent animals, and under these circumstances it might be as well not to torture them more often than can be helped. It is not very long ago that we remonstrated against the practice pursued in France of dissecting live horses, yet it would be difficult to prove that it is more cruel to cut up a live horse than a live frog, especially as the latter is evidently sensitive in no ordinary degree.—*Pall Mall Gazette.*

ZOOLOGICAL SOCIETY OF IRELAND.

At the thirty-ninth annual meeting of the Royal Zoological Society of Ireland, the Rev. S. Haughton, Secretary, read the annual Report of the Council, in which it was stated that the aquarium of the Society has fully realised the anticipations formed: it is kept constantly stocked with many varieties of sea-water and fresh-water fishes, and with sea-anemones, zoophytes, and crustaceans, procured from the coasts of Howth and Dalkey, in addition to rare forms of reptiles and fishes from America, presented to the Society by Prof. Wyville Thompson and Dr. Mapother. Several valuable additions have been made to the stock of animals during the year. Many valuable herbivores have died during the year of pleuropneumonia, including a sambar stag, a guanacho, and a llama. This result is mainly attributable to the deficient stabling accommodation for this class of animals.

SPONTANEOUS GENERATION.

In the number of the *Quarterly Journal of Microscopical Science*, Dr. Sanderson has discussed the question of the supposed "Spontaneous Generation" of Bacteria in certain solutions, which attracted attention first in France, and more recently, owing to Dr. Bastian's statements, in this country. Dr. Sanderson shows, firstly, that neither Bacterium nor Fungi ever develope in solutions raised to the boiling-point, and placed in carefully cleansed and boiled vessels, which are subsequently closed; secondly, that if such solutions in such flasks be exposed

to atmospheric air, no Bacteria ever develope, but yeast-cells, and ultimately blue mould, do develope (whence it is inferred that the germs of Fungi, but none of Bacteria, are carried in the air); thirdly, that if unboiled water be used, or glass or other surface not duly cleansed be brought in contact with the above-mentioned solutions, Bacteria always develope in great quantity (whence it is inferred that water, and surfaces which have been, or are more or less damp, are the means of dissemination of Bacteria). The series of experiments, the checks adopted, and the mode of handling the whole question exhibited in this memoir, contrast favourably with the impatient and unscientific treatment which the matter has received in other quarters.

DREDGING IN THE FIRTH OF FORTH.

After the close of the British Association Meeting at Edinburgh, an expedition proceeded by rail to North Berwick, whence the members were conveyed by steam to the Thane of Fife. The object was *Dredging*. It may be as well to premise that a dredge may be roughly compared to a landing net, on rather a large scale, and intended to be dragged along the bottom of the sea. It is made oblong, instead of circular, in order to give its lower edge a sufficient contact with the surface over which it is dragged. That used on the above occasion consisted of a rectangular iron frame, about 4 ft. long and 6 in. wide. On one side, the edges of this frame were somewhat everted, while on the other side a net was affixed. Two iron bars, one attached to a cross piece near each end of the frame, met in a common ring, to which a tow-rope was secured. When resting on the bottom, the dredge was dragged forward by the progress of the steamer, one edge, or "lip" of the frame in contact with the bottom, so as to scrape up from the surface, and then to retain in the net, any forms of subaqueous life that were encountered.

Besides a number of such dredges, the tug carried also a trawl, which is a net constructed on a similar principle, but of much greater dimensions, and calculated to retain flat fish and other larger denizens of the deep. Deep-sea dredgings have been carried on for short periods, at intervals, during the last three years, under the direction of Dr. Carpenter, Professor Wyville Thompson, and Mr. Gwyn Jeffries. These expeditions have been directed not only to bring up the life of the deep sea, but also to test its composition, and to measure its temperature and the force and direction of its currents. They have shown that the profoundest depths of the ocean, in which it was supposed that neither light nor life could exist, are inhabited by complex living organisms, possessing fully-developed eyes. They have shown that the deep-sea temperature, instead of being stationary at 39 deg., descends to just above the freezing point, that this temperature is so controlled by currents that an arctic and a temperate fauna may co-exist within a very short distance of

each other; that the process of chalk formation is still being actively continued by countless myriads of globigerinæ; and that the differences in temperature and density between equatorial and polar water are sufficient to maintain a constant interchange of both, by which various deep and superficial currents may be explained, and by which the rigour of northern climates is perceptibly modified in certain places. The statements contained in these few sentences are sufficient to invalidate the data on which many conclusions about the periods of geological time and the nature of geological formations have been based; and they open out altogether new views with regard to many of the chief problems of biology. They rest at present, upon observations neither sufficiently numerous nor made over a sufficiently extended area to be beyond the reach of doubt, and the influence of the Royal Society has induced the Admiralty to take up a similar line of research, with a view to its complete prosecution. For this purpose it is now announced that an expedition will be equipped next year, to be absent four years, and during that time to carry on deep sea dredging and deep sea temperature soundings, in every part of the ocean from which it is thought that valuable knowledge may be gained.—*Abridged from the Times.*

THE YOUNG HIPPOPOTAMUS.—Note to p. 186.

It may interest readers to learn that, in conjunction with Mr. Clark, the superintendent of the University Museum, and Mr. Anningson, I have made a careful examination of the Young Hippopotamus, which was received here from the Zoological Gardens on the day after it died, and have found no disease. All the organs were well developed and healthy. It would seem, therefore, that the animal was a victim to the influences of civilization, which had so far blunted the natural instincts and powers of self-preservation as to render mother and daughter unable to carry out between them the combinations requisite for the necessary process of nursing. The same difficulty is, we know, experienced in the case of some of our domestic animals, but in them the ferocity of the mother is not sufficient to prevent the timely aid of man, which is often needed to place the infant at the breast. This report of the examination and view of the cause of death is, on the whole, encouraging to the conservators of the gardens to persevere in their attempts to breed and rear these and other similar animals. On another occasion the arrangements should be made for an earlier capture of the infant, so as to bring it up by hand, which may probably be accomplished with success.—G. M. Humphrey, Professor of Anatomy. The Museum of Anatomy, Cambridge, Jan. 25, 1872.—*From the Times.*

BOTANY.

BOTANY OF THE ATLAS RANGE.

A PAPER which has been read to the British Association 'On the Ascent of the Atlas Range,' by Dr. J. D. Hooker, was, as might be expected, remarkably interesting and instructive. Dr. Hooker's main object was to investigate the botanical features of the Atlas range, but he was able also to afford us geographical information of considerable importance. In obtaining, through Sir J. Drummond Hay's great influence with the Sultan of Morocco, permission to visit the whole range of the Atlas from a point to the eastward of the city westward to the ocean, Dr. Hooker was obliged to promise to confine himself to collecting plants for the royal gardens, and to practising as a Hakim, so that he was unable to take any exact topographical observations. He, however, reached the crest of the main range, visible from the city of Morocco, which has long had the repute of being the loftiest of the whole great Atlas chain. The mountains present, as seen from Morocco city, a long ridge, apparently of tolerably uniform height—about 13,000 ft.—throughout its whole length, steep and rocky in the upper regions, with long streaks of snow descending in deep steep gulleys. But it offers no snow-capped peaks or slopes of any extent, nor glaciers, and the loftiest point of the jagged sky-line is not snowed at all. The scenery is rather pretty than grand, the climate is temperate, while the people inhabiting the native villages are generally very poor, owing to the iniquitous imposts levied by the government and chiefs, who punish inability to pay by devastating crops and burning houses. The botanical value of Dr. Hooker's paper was even greater than its geographical importance—supposing we separate the sciences in the manner wished for by some people—but this paper affords an excellent illustration in favour of Col. Yule's argument, which has been already quoted. The botanical and geographical features of the paper are so intertwined as to be practically inseparable—divert either of the other's aid, and it will lose half its value. Dr. Hooker saw no forest in any part of the range, the sole remains of the primeval woods being clumps of brushwood and isolated stumps of oak, juniper, carob, and ash. A ragged belt of starved oaks marks the limit of the former forests, occupying the very steep extremities of the spurs, at 8,000 to 9,000 ft. elevation. Notwithstanding the low altitude of the snow patches, the climate appears to be very dry, but Dr. Hooker found the temperature of Morocco far cooler than Spain, Italy, or Algeria at the same season. Ferns are extremely scarce, and low prickly herbs and shrubs prevail. Dr. Hooker was forced to the conclusion that these mountains, for their height and position, are the most barren he ever visited. Even moss and lichens were extremely poor and rare, compared with what other

alpine and sub-alpine regions present. The only ferns are those of dry climates, and the plants typical of the region are for the most part members of large and widely distributed genera.

Dr. Hooker's paper has added considerably to our geographical information, and by his investigation, as Dr. Cleghorn observed in the discussion, a great desideratum of botanical knowledge has been obtained.—*Athenæum.*

THE INK-PLANT.

THERE is a plant in New Granada which, if our ink-makers could only grow in sufficient quantity in this country, would be a fortune to them. The plant in question (*Coriaria thymifolia*) is commonly known as the Ink-plant, and it is simply the juice that is used, without any preparation. Its properties seem, according to a tradition in the country, to have been discovered during the Spanish administration. A number of written documents destined for the mother country were embarked in a vessel, and transmitted round the Cape. The voyage was unusually tempestuous, and the documents got wetted with salt water, those written with common ink became nearly illegible, whereas those written with "chanchi" (the name of the juice) remained unaltered. A decree was therefore issued that all government communications should in future be written with the vegetable juice. The ink is of a reddish colour when freshly written, becoming perfectly black after a few hours, and it has the recommendation of not corroding a steel pen so readily as ordinary ink.—*Nature.*

JAPANESE SILK.

SIR HARRY PARKES has forwarded to the Foreign Office a short report by Mr. Adams on the present condition of sericulture in Japan, and on the causes of the marked deterioration in the quality of Japanese Silk during the last few years. This deterioration is attributed in some measure to the hasty and imperfect system of reeling now practised by the natives, but still more to the excessive export of silkworms' eggs to France and Italy—a trade which has assumed very great proportions in consequence of the dearth of good seed in those countries, owing to the prevalence of the disease called pebrine. Mr. Adams is clearly of opinion that the high prices paid by foreigners for these eggs have prevented native breeders of the worm for silk from purchasing, as formerly, first-rate native seed year after year. They have, therefore, been obliged to content themselves with the inferior seed of their own localities, and hence the silk produced has deteriorated. Mr Adams also shows that this excessive production of seed has been the cause of the increase of the parasite called uji by the Japanese, and that there is evidence of an increase in the amount of pebrine, which may in the future become a very serious matter. There seems to be good reason to hope that

pebrine is moderating in Europe, and consequently less seed will probably be required in future years from Japan. Mr. Adams says:—"Beyond disseminating information among the people on the causes of the deterioration of their silk, I do not see what action can be taken beneficially. I am convinced that interference on the part of the Government would be more likely to do harm than good. The Japanese must come to see themselves what is best for their own interest; and if they find that the foreign merchant refuses to give large prices for their inferior silk, and that the demand for their eggs becomes less, while the prices offered for them diminish, they will surely be ready to adopt those changes which are manifestly required to restore the silk industry to its former level."

A committee on the subject was appointed at the meeting on the 14th of April of members of the Yokohama General Chamber of Commerce interested in the silk trade. The report of the committee, which is signed by five well-known silk inspectors of different nationalities—Messrs. Jaquemot, Scheidt, White, Barthe, and Le Mare—concurs with Mr. Adams's last report in designating as one of the causes of the growing deterioration of Japanese silk the excessive export of silkworms' eggs; it also enumerates other causes, such as bad and hasty reeling, reeling too fine, reeling foul silk and silk from double cocoons, &c.; and it proposes a series of recommendations for adoption by the native reelers and silk dealers, in order to restore the quality of the silk to its former excellence. Repeated attempts have been made to improve the production of silk in Japan, but no real progress has been made. The committee wish to make a last appeal to the native reelers and traders, warning them that a dislike for fine Japan silk has spread throughout Europe, and that unless these recommendations are earnestly carried into effect the markets of Europe will soon be shut against them, and the silk trade, which ought to be a source of profit and wealth to both Japanese and foreigners, will gradually be ruined. This report was discussed at a meeting of the Chamber held on the 8th of May, and met with much opposition from those members who are mainly interested in the export of eggs. The result was that the report was adopted by a narrow majority of three, and that propositions that the foreign representatives should be requested to forward the report to the Japanese authorities, and that it should be translated and circulated through the interior by means of the silk dealers of Yokohama, and by the Daimios and other officers in the silk districts, were also carried.

VEGETABLE PARCHMENT.

The common method of preparing this exceedingly useful material requires much care and experience on the part of the operator, and only gives satisfactory results when the strength of the sulphuric acid and length of the process is accurately appor-

tioned to the substance and texture of the unsized paper to be dipped. Mr. Colin Campbell has made a modification of this process, which promises many advantages. Before treating the paper with sulphuric acid, he dips it in a strong solution of alum, and dries it thoroughly. When paper thus prepared is passed through concentrated sulphuric acid it is converted into parchment paper just as before, but the presence of the alum prevents the action of the acid from being so rapid as before, and therefore renders the whole operation much more manageable. Paper which has been printed on can also be converted into vegetable parchment if treated in this way. The author also proposes to make parchment paper in endless lengths, by connecting the alum and sulphuric acid bath with the paper machine.—*Dingler Polytechnic Journal.*

UNITED STATES COTTON.

THE cultivation of Cotton in the United States commenced with this century, and it rose from 400,000 bales in 1820 to 5,000,000 in 1859 and 1861, the two most productive years. The price fell during the same period from 50c. to 10c. a pound. Since the end of the civil war cotton cultivation has rapidly increased, and it is estimated that the quantity gathored during the past season will reach 4,000,000 bales, an amount which has only been surpassed in 1859 and 1861. But the war between France and Germany has influenced the price in a most disastrous manner, and cotton which a year ago sold for 25c. a pound, now obtains only 15c.—*Journal of the Society of Arts.*

BRITISH COLUMBIAN TREE.

THE *Vancouver Island Standard* states that the largest Douglas pine known to exist on that island is one near Mr. Richardson's house, Chemainis prairie, on the edge of the trail, and not far from Chemainis river. It is 51 feet in circumference, or about 16 feet in diameter, and about 150 feet high. Originally it was at least 50 feet higher, but the top has been broken off either by lightning or storm. It is a monster, and need not be ashamed of its proportions were it among the gigantic trees in the famous Calaveras grove. Two gentlemen who recently visited it christened it "The Old Guardsman," it must have been standing guard centuries before any of the trees around it.

BOTANICAL GARDENS IN EUROPE.

THE first botanical garden established in Europe was created in Padua, in 1545; the second was the one of Pisa. Those of Leyden and of Leipsic date respectively in 1577 and 1579. The garden of Montpellier was founded in 1593; that of Giessen in 1605; the one of Strasbourg, in 1620; of Alfor, in 1625; of

Jena, in 1629. The "Jardin des Plantes" of Paris was established in 1626; that of Upsala in 1627; of Madrid in 1763, and of Coimbra in 1773. At the end of the 18th century there were already, according to Gesner, more than 1,600 establishments of the kind. England began later, for the Oxford Garden was only founded in 1632, and long remained the only one of the kind in the United Kingdom.

The Jardin des Plantes and the Jardin d'Acclimatation are empty. The animals have all been killed and sold at fancy prices. Two young elephants were sold at 27,000f. to a butcher, who has made a speciality of such game. The skin was at once sold for 4,000f.; the feet, trunk, and other parts sold enormously dear. The kangaroos and deer of all kinds, cassowary, wild geese, ducks, pheasants, &c., all passed away long since. The Parisians have had the opportunity of tasting bear hams, camel hump, seal flesh, eagle, parrot, and I know not how many other strange birds and beasts. "Camel eats like veal," says one, "seal like lamb, and bear like pig." "Why do you not eat monkey?" says another, "for monkeys imitate everything."

MIMICRY IN PLANTS.

Mr. W W. T. Dyer has read to the British Association a paper "On so-called Mimicry in Plants" The author said, "In all large natural families of plants there is a more or less distinctly observable general habit or *facies*, easily recognisable by the practised botanist, but not always as easily to be expressed in words. The existence of such a general habit in Leguminous and Composite plants is familiar to everyone. What have been hitherto spoken of as *mimetic* plants are simply cases where a plant belonging to one family puts on the habit characteristic of another. This is entirely different from mimicry among animals, inasmuch as the resembling plants are hardly ever found with those they resemble, but more usually in widely different regions. *Mutisia speciosa*, from western South America, a Composite, has a scandent leguminous habit, closely agreeing with that of *Lathyrus maritimus* of the European shores. In the same way, three different genera of ferns have species (found in distant parts of the world) indistinguishable in a barren state. The term Mimicry seems objectionable in these cases, and I propose Pseudomorphism as a substitute. As to the cause of the phenomenon, I can only suggest that the influence of similar external circumstances moulds plants into the similar form most advantageous to them. An illustration is afforded by the closely resembling bud scales which are found in widely separated natural orders of deciduous trees as modifications of stipules. I do not, however, think that the moulding influence need always be the same. I believe that different external conditions may produce the same result; in this respect they may be called analogous. Several identical plants are found on the seashore

and also on mountains. The reason is, I believe, that they are equally able to tolerate the effect of soda salts and also of mountain climate; the tolerance of either unfavourable condition gives them the advantage over less elastically constituted plants, and the two are therefore analogous in their effect."

THE BARBERRY.

FARMERS long held the notion that the presence of the barberry (*Berberis vulgaris*) in their hedges was prejudicial to the wheat crops in the adjacent fields. As there seemed on the surface no good reason for this, botanists and scientific men scouted the notion. That the fungus so common on the berberis (*Æcidium berberidis*) should have anything to do with the *Uredo rubigo* of the wheat, or with the puccinia, seemed too absurd a notion to be at all credible. Nevertheless, changes as strange do occur in other cases, and the forms and stages through which some of the fungi pass should at least lead us to give a fair hearing even to the enunciation of the most startling notions, provided they are made by persons whose attainments are such as to warrant us in placing some confidence in their judgment. Few things in nature, for instance, can be more unlike than the fleshy orange-coloured fungus so often found on the savin (*Podisoma juniperi sabinæ*), and the small crisp flask-like fungus which appears on the leaves of pears (*Ræstelia cancellata*), yet it was shown by Professor Oersted, of Copenhagen, that the one is but a form of the other. The Danish professor, as we have previously recorded, proved this by inoculating the pear with the fungus of the savin. Naturally the statement was received with incredulity, and requires the concurrent testimony of many witnesses before it can be definitely accepted One such witness is M. Rozo, who repeated Oersted's experiments with success. Last May we had an opportunity of seeing in Paris another case of the same nature, in which the French botanist just named had succeeded in inducing the presence on the hawthorn of *Ræstelia* (*æcidium*) *lacerata* by placing on the young shoots the minute spores of another fleshy fungus commonly found on the juniper, viz., *Podisoma clavariæforme*.—*Gardener's Chronicle.*

A NEW PANACEA.

AN interesting discovery has been made in America—namely, that "the germ of all growth and life lies in blue or violet glass." The gentleman who discovered this secret has given it to the public in a pamphlet, in which he tells the results of his own experience. Under blue glass in a grapery in five months two-inch vines had grown 45 ft. He next tried the effect of violet glass on pigs, and found it answered admirably. Three sows living in a piggery roofed with glass of this hue increased 12 lb. almost immediately, and a barrow pig reached an alarming state

of obesity, even more rapidly than the sows. He then experimented on an Alderney bull calf just born and apparently dying. Under the influence of this coloured glass the calf revived in a few hours, took to feeding with great vivacity, began to grow next day, and was "full-grown in four months." By roofing our houses with violet-coloured glass "we can produce in the temperate regions the early maturity of the tropics, and develope in the young a generation, physically and intellectually, which will become a marvel to mankind."

REVIVAL OF FRUIT TREES.

George B. Wood, M.D., reiterates the arguments urged as to the benefit arising from the copious use of potassa salts in the manures applied to fruit trees. This experience bears out the view that the manure should be in accordance with the chemical composition of the plant to be recruited by it. The form in which he prefers to apply the salt is in that of ashes of plants which contain a large percentage of it, such as potato stems, beans, &c., which contain as much as five per cent. In the autumn of 1869 he dug round the stems of half the trees in an old orchard, which had not borne fruit for five or six years, to the depth of five inches, and filled up the space with about half a bushel of fresh ashes In the following spring and summer a dividing line might have been drawn between the two sections of the orchard, the trees which had been treated with ashes being forward and full in both leaf and blossom, and subsequently presenting a still more marked contrast as the autumn came on and they were loaded with apples, while the other trees remained barren. Exceedingly favourable results were also obtained when aged peach and plum trees were treated in a similar manner. Crude potash may also be used, but care must be taken that it is sufficiently diluted before it is applied.—*Amer. Phil. Soc., Philadelphia.*

VENTILATION OF PLANT-HOUSES.

The most simple plan, says a Correspondent of the *Notts Guardian*, is to carry a fresh-air drain communicating with the external air beneath the hot-water pipes, with openings every few feet to allow the air to pass into the house, the hot-water pipes having troughs upon them to hold water for evaporation. Another plan, which cannot be surpassed for vineries or forcing-houses of any kind, is to carry drains formed of 6-in. common socket drain-pipes, and 4 ft. apart, from the front to the back of the border, terminating beneath the heating apparatus. This we did thirty years ago with perfect success. First, the return-pipes of the heating apparatus were laid in a cement trough 6 in. deep, which could be filled with water for evaporation or not as the exigencies of cultivation might render it necessary. In front

of the pipes, beneath the platform upon which the plants stood, was a curtain of coarse woollen netting, through which the heated air passed into the house, and as the cold-air drain terminated behind the trough in which the pipes were laid, it was impossible that air could pass among the plants until attempered to their requirements. Nothing could be more satisfactory than this. Of course with all arrangements for admitting fresh air, there must be a corresponding outlet. In some cases "the chink of air" in the roof may be sufficient for the purpose, except when the day is sunny, but in any extreme it is only necessary to place a light framework of wood before each ventilator, which, covered with fine woollen netting, will check the ingress of cold air, and regulate the egress of warm.

BEETROOT IN ITALY.

THE Italian Government is greatly interested in the introduction of this industry into Italy, and during last year one of the Ministers of Public Works visited all the sugar manufacturing districts of Germany, France, Belgium, and Austria, with the view to learn how this industry was carried out in those nations and, in short, to study the various exigences connected with the manufacture of beetroot sugar. There have also been various societies formed in Italy to further the progress of this important industry. A society of this kind has recently been established in Turin, the object of which is to introduce the manufacture of sugar; and similar associations with analogous ends in view have been formed at Césa (in Tuscany), Riéti, and other places. The beetroot which has been yet produced in Italy has been proved to possess great saccharine richness, and is in every way suitable for the purpose to which it is to be devoted. In order, also, to stimulate the cultivation of this industry, it is stated that the Italian Government has concluded an arrangement by which the manufacture of beetroot sugar in Italy is practically monopolised, the Government having already promised a privilege for 25 years, and granting complete exemption from duty and other advantages, even the partial prohibition of the entrance of foreign sugar into the country. It may be mentioned that Italy has only recently given attention to the cultivation of beetroot sugar. In the year 1868 a gentleman named Montanari, a proprietor in the Pontifical States, made some attempts to cultivate beetroot, which resulted most successfully, the roots yielding, upon analysis, undoubted saccharine properties. The Papal Government granted great privileges to M. Montanari, and it is stated on good authority that the Italian Government, having annexed the States of the Pope, is inclined to confirm these privileges, but only so far as the Papal States are concerned. From this and other circumstances it will be seen that the manufacture of beetroot sugar in Italy is likely to become an industry of great importance.—*Times*.

Geology and Mineralogy.

THE MICROSCOPE IN GEOLOGY.

Since Mr. Sorby drew attention to the importance of examining the structure of rocks by the aid of the microscope, the practice has been steadily extending itself. Prof. Geikie, Mr. J. A. Phillips, and others in this country, have made good use of the instrument, and we find M. G. Tschermak communicating to the Academy of Sciences of Vienna the researches of M. J. Niedzwiedzky on the microscopic constitution of the igneous rocks of Aden, consisting of obsidian trachyte and basalt.

PHOSPHATE OF LIME.

The *Institut* of November gives a full account of M. Dumas, on the deposits of phosphate of lime discovered in 1865 by M. Poumarède. These deposits are now attracting much attention, and works are commenced upon them with the object of supplying the agriculturists with a valuable manure. These phosphates give, by analysis, 32 62 per cent. of phosphoric acid.—*Athenæum.*

NATURAL GAS LIGHTING.

The *Iron Age*, U.S., gives an interesting account of the gas-wells of Erie. The average depth of the wells sunk is 600 feet, and they yield from 10,000 to 30,000 cubic feet of gas a day. In the manufactories of the city this natural gas is burnt without any other fuel for raising steam, and in many private houses no other fire is employed. The City of Erie Gas Company have a well pouring 24,000 cubic feet of gas a day into their gasholder; this, mixed with 12,000 feet of ordinary coal-gas, furnishes the supply for illuminating the town.

THE YELLOWSTONE VALLEY.

Professor Hayden, who has been engaged for four years on a geological survey of the United States' territories, has returned to Washington, and will proceed to prepare his annual report, which will include the survey of the famous Yellowstone Valley. The expedition to that valley left Utah in June, and explored a belt of country to Fort Ellis, Montana, proceeding then into the Valley of the Yellowstone. Professor Henry, secretary of the Smithsonian Institution, has received a letter from Mr. Elliott, the artist who accompanied the expedition, giving an account of the "Great Cañon," a huge basaltic fissure or rent in the earth, beginning at Tower Creek, and ending at the foot of the Lower

Falls of the Yellowstone. Hence, it is 25 or 30 miles long. The cañon varies from 1,000 to 2,000 feet in depth, and along its bottom the river whirls with immense velocity, appearing from above "now a blue and now a snowy riband." The attrition of the stream for ages has worn the sides of the chasm into strange shapes of "towers, points, and pinnacles," and these are "gaily painted by the waters of the numberless warm and hot springs which ooze out from the fissures into a variety of tints and tones, dazzling white, intense red, purple, saffron, yellow, &c., and fairly bewildering the eye, at first, by their singularity and grandeur." The cañon is moreover fringed in some places with rows of basaltic pillars quite regular in form, from 20 ft. to 30 ft. high, and standing, without crack or flaw, in regular tiers one above the other. The great Falls are more imposing still. They are a "broad, evenly deep sheet of clear ice water, leaping down at one bound 450 ft." Unbroken by any point or division, they rush over the ledge, a vast curtain, as of swift, foaming lace. These are the Lower Falls, the Upper being just the height of Niagara, or 150 feet, and but half a mile distant from the other. Thus, within that short space the stream makes a descent of 600 feet. But the chief marvel of this section would seem to be the "Geysers of the Firehole Basin." These are the headwaters of the Madison, and in magnitude and extent of area reduce the famous boiling springs of Iceland to complete insignificance. Mr. Elliott writes:—"I have stood by a crater, and have seen a column of hot (boiling) water 6 feet in diameter ascend with a single bound, vertically, to a height of 200 feet—pause there for an instant, and fall to its silicified basin in a thousand water streams, and a million prismatic drops. This was repeated ten or fifteen minutes; then all would be quiet; the water of the cistern became as still as that of a mill-pond, and apparently as inactive. This geyser, which is one of many, we named the Grand. It plays at irregular intervals of twenty-four to thirty-hours, for from ten to twenty minutes. Another, named by Doane 'Old Faithful,' plays at intervals of only an hour apart, throwing up an immense steady column to an elevation of 150 ft." There are fifty geysers, and over a thousand boiling springs, according to this authority, within 50 miles of each other, and it is evident that these objects must rank among the wonders of nature.

THE GLACIAL EPOCH OF GEOLOGY.

There has been read to the Geological Society a paper "On the probable Cause, Date, and Duration of the Glacial Epoch of Geology," by Lieut.-Col. Drayson, R.A. In this paper the author started from the fact that the pole of the ecliptic could not be the centre of polar motion, as the pole varied its distance from that centre. He indicated the curve which the pole did trace, and this curve was such as to give for the date 13,000 B.C., a climate very cold in winter and very hot in summer for each

hemisphere. The duration of the glacial epoch he fixed at about 16,000 years. The calculations resulting from this movement were stated to agree accurately with observation.

QUATERNARY MAMMALIA AND THE GLACIAL PERIOD.

Mr. Dawkins has read to the British Association a paper "On the Relation of the Quaternary Mammalia to the Glacial Period," giving a clear outline of a very puzzling question. He divided these mammalia into five distinct groups, the first of which consists of those now living in the temperate regions of Europe and America, among which the more important were the grizzly bear, the lynx, the bison, and the wild boar. The second group comprises those animals which are now restricted to cold regions—the glutton, the reindeer, the musk sheep, and the tailless hare. They constitute the Arctic division of Quaternary mammalia, and imply the former prevalence in England of a cold climate. The third group, on the other hand, consisting of those animals which are now only found in hot regions, such as hippopotamus, &c., gives evidence of a warm climate. Mr. Dawkins believed that the only mode of reconciling the apparent discrepancy of this evidence with that furnished by the preceding group, was to suppose that at the time these animals lived the winter cold and summer heat were strongly contrasted, so that in summer the animals which are now confined to warm regions found their way northward, while in the winter time the Arctic forms travelled southwards. The fourth group consists of the extinct forms...the cave-bear, the mammoth, &c.; and the fifth group embraces those animals whose remains occur both in Pliocene and Quaternary deposits. The interest centred more especially in the Arctic group; and the author thought there could be no doubt that the animals belonging to this group were in occupation of those areas in Britain where their remains are now met with, at a time when glaciers and snow-fields covered the higher levels of the country. This period might be referred to the latest sojourn of the glaciers in our country.

In the discussion that followed, Mr. J. Geikie remarked that, from the evidence supplied by the drift-beds of Scotland, it was not unlikely that some of the English deposits containing Arctic mammalian remains might yet have to be classed with the older period of glaciation, namely, that of the lower boulder-clay. He showed that during the great glacial epoch there had been several oscillations of climate, the less Arctic periods being represented by fresh-water beds with mammalian remains, such as *Bos primogenius*, the reindeer, &c.

SOUTH AFRICAN DIAMOND FIELDS.

Mr. R. Vause states, latest finds referred to as having been made in the Cape Colony proper are "several stones from 30 to

50 carats and smaller, of inferior quality." These finds were on the farm belonging to a boer named Prieska, on the banks of the Orange river. Other finds were at the same time reported from Renshooght, 20 miles higher up that stream. Mr. Vause adds that he has received a note from Mr. Streeter, the jeweller, of 37, Conduit Street, in reference to his remarks on the so-called diamond matrix in his possession, and which consists of a number of diamonds cemented together *en masse*. Under the microscope it is most interesting, and as a unique formation undoubtedly affords ample scope for scientific investigation.

Mr. Harry Emanuel, of New Bond Street, has communicated to the *Times* the following, in correction of the erroneous notion that the product of the Cape of Good Hope mines must cause great decrease in the value of diamonds:—

"It has been computed that the yearly average yield of the Brazilian mines is something like 800,000 yearly, and that of the Indian, Borneo, and Australian from 150,000*l.* to 200,000*l.* value, so assuming for a moment that the value of the total annual yield from the Cape mines to be as stated in your article, 200,000*l.*, we should arrive at the conclusion that the Cape has only sent us in one year the same amount as the other places collectively supply in two or three months.

"As a matter of fact, however, the valuation fixed on the diamonds sent from the Cape has been considerably in excess both of their worth and of the amount for which they have been sold. Unfortunately, also, the quality of the yield, being in most cases inferior to that of India and Brazil, the new discovery has as yet had no influence at all on the prices of the ordinary sizes in use."

Messrs. Williams & Hill have also communicated the following:—

"The majority of the specimens of South African diamonds which we have seen have been most inferior in quality, and simply of value for stone-cutting, engraving, and other purposes; doubtless there may have been many fine diamonds found, but what have they realised? Not low prices, but, on the contrary, higher prices than ever, and, we say it advisedly, and without fear of contradiction, that to-day fine diamonds are more scarce and more valuable than ever. We, and all diamond merchants, are giving a higher price for all fine gems than has ever been given before at any period upon record—buying back jewels sold many years since at much more than they were sold for; and at every public sale it is a well-known fact that there is greater competition than ever for fine gems. Small double-cut white brilliants are fetching to-day 11*l.* per carat, and a fine spread carat stone 25*l.* cash. Who can assert that diamonds are cheaper, or plentiful, when such is the case? And expensive as diamonds were in 1861, they were then not so high in price as at this time."

GOLD FIELDS OF VICTORIA.

AUSTRALIAN papers report that the gold-mining interest of Victoria has, in the month following the despatch of the July mail, been rather devoid of incidents of special interest; but the work has been pursued with steady success in all the various gold districts of the colony. Ballarat, the metropolitan goldfield, has certainly not recovered from the dulness and stagnation into which it has fallen during the last year or two; but the magnificent gold-bearing quartz-reefs of Sandhurst and the general prosperity of other mining districts compensate fully for the diminished yields of Ballarat. Even on Ballarat two matters have lately occurred which afford well-grounded hope that the yields thence will be increased before long. One of those matters is the new system, or rather a return to the old system, of co-operative mining, many of the working miners having banded themselves together in companies to prospect ground not hitherto worked, though always held to be auriferous, and also to mine in ground only partially operated on in former years, when the inefficient apparatus of those times was not sufficient to cope with the difficulties met with. The other matter referred to is the great attention being paid to what are termed the Dead Horse Ranges, where there are some 30 or 40 square miles of gold-bearing quartz-reefs, which in some places are as much as 18 ft. thick. All these reefs that have been tried up to the present time have proved auriferous in some degree. A number of co-operative companies are now at work on reefs, and though as yet those operated on are only moderately profitable, they may eventually turn out to be highly remunerative, and the country around be proved to be crossed by reefs, which, like many others in this colony, may be almost inexhaustible. Many of the quartz-reefs in this colony now giving splendid returns to their owners or shareholders were prospected or worked upon for years before anything like good yields were obtained. The export of gold, as published in the Customs returns, affords proof of the stability and increased profitableness of the goldfields. The amount of Victorian gold exported to the end of July this year was 872,940 oz., while the amount for the corresponding portion of last year was only 759,499 oz., or 113,441 oz. less than the return for this half-year.

In the *Buninyong Telegraph* of November 3, we find records of a nugget weighing about 9½ lbs. about 18 in. under the surface. A "monster" cake of gold, the result of a fortnight's crushing of the Great Extended Hustler's Tribute Quartz Mining Company, Sandhurst, was recently exhibited at Melbourne. It weighed no less than 2,564 oz., was worth over 10,000*l.*, and was said to be the largest cake ever obtained by any company.

AMBER.

A LARGE proportion of the Amber appearing in the various markets of the world is supplied by the province of Prussia, in-

cluding the neighbouring district of Memel. The amber trade in this district is entirely in the hands of one firm, and their transactions are kept very secret. In the western portion of the province of Prussia, amber is found not only on the seashore, but also in the mountainous ranges of the interior; excepting, however, in rare cases of its appearance in so-called "nests," amber is to be met with in isolated pieces in the latter localities. It is frequently thrown upon the shore by the sea in large quantities; it is collected there, as well as fished for in the surf; it is also dug out of the sand hillocks running along the sea coast. In these sand hillocks regular beds of amber are found enclosed in a soil of blue clay, which is to be met with at an average depth of about 100 ft., in a thickness of 25 ft to 30 ft. There are establishments at Brusterort, where amber is obtained by divers from the bottom of the sea. The total amount of amber obtained during the year 1869 in all parts of the province of Prussia by the various means of collection is estimated at about 150,000 lb, the value of which may be taken at 550,000 Prussian dollars. The quantity collected (by fishing for it) in the sea and upon the shore is about equal to that raised by the digging and dredging works.—*Builder.*

PETROLEUM OILS.

THE general employment of the Petroleum Oils and the occasional ignition of their vapours render every inquiry into the nature of those hydrocarbons of interest. H. Byasson has, in the *Comptes Rendus*, some valuable researches on the Pennsylvanian oils. He states that they furnish *fourteen* volatile hydrocarbons, boiling at different temperatures. M. Byasson thinks the ordinary methods used for testing the inflammability of those oils unsatisfactory, and he proposes an apparatus for determining the tension of the vapours given off at different temperatures, instead of the usual somewhat rule-of-thumb method.

LAKE DWELLING ON LOCH ETIVE.

DR. ANGUS SMITH, of Manchester, who has been exploring in a large moss on the shores of Loch Etive, has discovered the remains of a Lake Dwelling, the platform of which is 60 feet in diameter, with the dwelling in the middle 50 feet in length by 28 feet in breadth. He also discovered in a large cairn a megalithic structure, consisting of two chambers, each 20 feet in length, connected by a narrow passage nearly as long. The Rev. R. J. Malleton, of Dumbarton, who, along with several others, has visited the remains, believes no other cairn like it has been yet discovered in Scotland. It allies itself, he thinks, more to that of New Grange, in Ireland, than any other, although it is much smaller. One broken urn and the remains of four others were also discovered.

DISCOVERY OF CRANNOGS.

A correspondent of *Nature* says that a considerable number of Crannogs, various articles of the new stone period, and some "kitchen-middens" have been discovered in connexion with the small lochs which stud the surface of Wigtonshire and Dumfriesshire. Dowalton Loch, Machermore Loch, and the lochs which surround Castle Kennedy in Wigtonshire, have been examined within the last few years, and have disclosed ancient lake dwellings. The Black Loch of Sanquhar and Lochmaben Loch in Dumfriesshire contain platforms of wood and stone. In some cases canoes and causeways connecting the artificial islands with the adjacent shores have been traced.

NEW CAVERN IN NORTH LANCASHIRE.

A large Cavern has been discovered in the mountain limestone formation at Stainton, near Ulverston, in the Furness district of North Lancashire. The valuable hæmatite iron, found so abundantly in this district, is deposited in "sops" or "pockets" in the mountain limestone; but occasionally openings in the rock occur, either empty or full of drift, as in the case of the bone-caves of Kirkhead and Capeshead. With the exception of the last-mentioned caverns and a few fissures in the rocks, no opening of any importance has been found until the recently discovered cavern at Stainton. Immense ridges of limestone exist at this place, and since the opening of a branch of the Furness line of railway hundreds of tons of the rock have been carried away weekly to the neighbouring smelting furnaces of the Barrow Hæmatite Iron and Steel Company, as a flux. Escarpment after escarpment has been cleared away, and in an immense cutting in the rock, where the railway terminates, about half way up the face of a perpendicular cliff, 100 feet high, is the entrance to the cavern. For a distance of about 40 yards the visitor is able to walk in a stooping position, after which he must crawl through a mud-lined passage eight or ten yards in length, when the cavern widens suddenly and continues along a chamber 15 feet high and 15 feet wide. Another narrow passage, and another chamber with a floor entirely covered with waved and fretted white crystallised carbonate of lime; then a descent of 5 or 6 feet, and the principal chamber is entered, being about 130 yards from the entrance. Several "cross roads" have been found branching out from the main way. The principal chamber is a long gallery, 5 feet wide and about 7 feet high, its roof arched. It takes a north-eastern direction for nearly 80 yards, when it turns suddenly to the north-west, preserving its gothic-arched roof and regularity of height and width all the time. Water-washed boulders of the upper Ireleth slate were found upon the clayey floor. At this point the roof rises from 6 feet to more than 30 feet, and a chasm yawning beneath. This extraordinary abyss proved to be shaped

like an hour-glass. An exploring party found a chamber opening out of the lower cone of this strange pit, 70 feet long and 35 feet in breadth, but they could not determine the height. The cliff in which this cone is situated is 300 feet above the sea level. The great problem of the deposition of the valuable hæmatite iron ore in similar chambers and galleries and basins has yet to be solved.

KENT'S CAVERN EXPLORATIONS.—ANTIQUITY OF MAN.

MR. PENGELLY has brought up his "Seventh Report on Kent's Cavern Explorations." He prefaced his report, however, with an account of the situation and general appearance of the cavern, explaining the succession of the beds that cover its floor, and pointing out the relative position of the numerous organic remains with which these beds are more or less charged. In exploring "Smerdun's" passage, a very large number of mammalian remains had been discovered. No fewer than 2,200 teeth had been obtained in this part of the cave since August 1870. The list of species to which these teeth belonged differed from previous lists, referring to other parts of the cave, in containing neither sheep nor pig, and in the diminished prevalence of rabbits and badgers Twelve flint flakes were found, but none of these could compare with the fine specimens met with in previous years in other parts of the cave.

CAVERN AT TINTAGEL.

SOME 300 ft. beneath the Castle of Tintagel, on the south coast of Cornwall, is a long narrow Cavern extending through the entire promontory. Here, at high tide, the restless sea dashes and surges through with unearthly noise, doing its utmost to destroy and carry away the soft foundation rock of the royal fortress above. The formation of this cavern has given rise to much speculation among geologists, but recent discoveries have now determined its origin. It would appear that a vein or lode of argentiferous mineral passed through it, as along the roof may be seen a thin layer of malachite, with spots of silver ore (*polytelite*). It was hence, no doubt, that in bygone days the mineral was derived, from which were coined King Arthur's "silver crowns" in the royal mint overhead. The date of this exploration, like that of the castle, there is no means of now discovering; but there is evidence enough to show that the excavation was done by the aid of fire and water, before the invention of gunpowder—a method sometimes adopted at the present time in prospecting in remote regions. An examination of the strata by Mr. T. A. Masey, F.G.S., has led to the finding of a parallel vein to that in the cavern. This discovery is attracting as much attention as the castle itself, as from the underlie of the veins being seaward, explorations are now being carried out under the castle and also beneath the sea. The miners appear to have no fear of the ocean

breaking in upon them, although they can hear the rattling of the shingle on the beach, nor of being inconvenienced by water, as, strange to remark, the excavations are drier than would be the case at a similar depth on land, probably owing to the absence of springs under the sea.—*The Builder*.

BONE CAVERN IN PENNSYLVANIA.

A Bone Cave of Eastern Pennsylvania is attracting considerable attention. Mr. Wheatley states that he has obtained from it from thirty to forty teeth of Megalonyx, three in the jaw; and parts of seventeen individuals of the Sloth tribe. Prof. Cope describes forty-one species of vertebrate animals found in it, and Dr. Horn has described fourteen species of insects. The locality of this cave is in the limestone quarries at Port Kennedy, Upper Merton Township, Montgomery County.

BONE CAVERN IN PHILADELPHIA.

A Bone Cavern has been discovered by Mr. Charles M. Wheatley, in the calciferous limestone at Port Kennedy, about 25 miles from Philadelphia. The fissure was 40 feet deep, 15 feet in width, and of unknown length. Above the cave deposit it was filled with the wash from the neighbouring "triassic" hills. The remains are of plants, insects, and about thirty species of vertebrata. These latter consist of reptiles, birds, and mammals. The first are serpents and a few tortoises, the birds include a turkey and a snipe. The mammalia present the greatest variety. There are rodentia of. American types among the ruminants, several tapirs, and a small horse, while a large cat and a bear represent the carnivora. Remains of several gigantic sloths (new to science), and the teeth and tusks of a mastodon were also found.

HYENA'S DEN IN HEREFORDSHIRE.

The Rev. W. S. Symonds has read to the British Association a paper on the contents of a Hyena's Den on the Great Doward, Whitchurch, near Ross, Herefordshire. During excavations for iron ore there were discovered bones of mammoth, rhinoceros, and horse, many of which seemed to have been gnawed by hyenas. Pottery had been found in the *débris* which had fallen from the roof, together with unfossilised human bones, and, in an inner cave, flint flakes and stone instruments of human manufacture, and remains of extinct mammalia. The paper concluded by saying that, from the facts detailed, it seems safe to draw the following inferences:—

"That long years ago King Arthur's Cave was a deep fissure in the rocks of the mountain limestone, which was gradually silted up by the introduction of the lower cave earth by the wash of rain and water through crevices and fissures; and that during that period it was a hyena's den, and also the occasional haunt

of ancient Herefordian men, who left there their manufactured weapons and sharpened tools. These implements are all foreign to the district, for the flints, &c., have all been imported from long distances. A thick floor of stalagmite seals this lower earth in the fissure, which was bored to the depth of 20 ft. Above the thick stalagmite we found that there rested stratified sand and gravel of considerable thickness. It is my belief that this deposit was washed into the cave by a backwater of an ancient wye, which flowed 300 ft. above the level of the existing wye, and when the land was higher than at present, before it was so much degraded by the atmospheric denudation of ages, and before it had assumed its present aspect of deep valleys and glens, It is probable that the soft Old Red strata north of the Great Doward never rose higher than the harder limestones of the Dowards and that ages of atmospheric wear and tear have reduced their height since the land was occupied by ancient man and the cave animals. Mr. Lucy thinks the drift sand and pebbles in Arthur's Cave may have been derived from the washing in of the materials and the agency of melted snow and ice from higher sites and previously deposited levels; but I prefer the hypothesis that these pebbles were washed in by the stream of an ancient wye before the excavation of the mountain limestone gorge to its present depth, 300 feet below. Be this as it may, there rest that sand and pebbles, sealed by a stalactite floor, the droppings of the cave roof upon its stratified layers, and itself separated from a lower cave earth by a mass of stalagmite more than 2 feet thick. In that ancient cave earth are associated the remains of ancient men and the extinct mammalia; and what with the evidence of the old river bed and the stalagmites, I doubt if there be better authenticated evidences of the antiquity of man in the records of cave history."

The reading of this paper occasioned some rather brisk talk about the Antiquity of Man. This cave showed two beds of earth charged with the remains of extinct mammalia and some flint implements. The two beds were separated by some three or four feet of red sand and silt, and a thick stalagmitic accumulation, Mr. Symonds argued from this that the lower cave must be of extreme antiquity; for he was of opinion that the red sand and silt had been washed into the cave at a period when the river Wye flowed at a much greater height than it does now, the gorge through which it makes its way at present being some 300 feet below the level of the cave. Prof. Hull remarked that, however ancient these cave deposits might be, it was quite clear there was no evidence to prove that man had existed in this country previous to the advent of the glacial epoch. Mr. Vivian, on the other hand, held that a glacial climate had occurred after the appearance of man. This might not be the great glacial epoch, but it was a time when the rein-deer lived in the country, which he thought proved the prevalence of cold conditions in England after man had become a native. Mr. Prestwich referred to the

so-called discovery of human remains below glacial drift in France, but the evidence, he thought, was not satisfactory. The fact of the non-occurrence of human relics in pre-glacial deposits was admitted by Mr. Pengelley, but this he was quite sure did not militate against the generally received opinion of the vast antiquity of our race.—*Athenæum.*

FOSSIL CRUSTACEA.

Mr. Woodward has brought up to the British Association his "Report on Fossil Crustacea." During the past year 23 new species had been discovered and described. These included 6 decapods, 1 amphipod, 2 isopods, 1 eurypterid, and 13 phillopods. He referred to the wide distribution of a new cretaceous isopod (*Palæga Carteri*), found in Upper Silesia, in Turin, and in three distinct localities in England, Dover, Beds, and Cambridge. Another isipod had also been detected in the Old Red Sandstone of Hereford, thus carrying back this group to palæozoic times; whilst an amphipod had been described from the Lower Ludlow rocks of the same county. Mr. Woodward pointed out that if the conclusions arrived at by Mr. Billings and himself as to the trilobites possessing legs be established by further research, then that group would carry the isopodous class back in time to our earliest palæozoic rocks. He did not agree with Dr. Packard, who, from an examination of the larvæ, proposed to place the king-crabs with the trilobites, as nearer allied to these than Pterygotus. A classification based on embryological characters alone could not be trusted, for all larvæ have a strong family likeness, but do not present such differences as serve to guide the naturalist in minor details of systematic classification.—*Athenæum.*

SIVATHERIUM GIGANTEUM.

Dr. Murie has read to the British Association a paper "On the Systematic Position of the *Sivatherium giganteum.*" The paper was illustrated by a number of diagrams, among which was a large cartoon giving a "restoration" of this remarkable form. The author was inclined to place the Sivatherium in the family Antilocapridæ, although he thought there were many reasons for taking it as the centre type of a family, the Sivatheridæ.

EARTHQUAKE IN THE NORTH OF ENGLAND.

On Friday night, March 15, 1871, an earthquake was distinctly felt in the northern counties of England. At Carlisle there were more shocks than one. The first was much less severe than the second, which occurred a few minutes afterwards. At Silloth and Aspatria, 20 miles west and north-west of Carlisle, the windows of houses were shaken with alarming violence. A gentleman who resided near Aspatria states that he felt the floor

of the room in which he was sitting heave, the piano was perceptibly moved. and a statuette upon it was rocked so much that it was nearly overturned. At Castle Canock, on the eastern side of the county, the windows were severely shaken, and the experiences of inhabitants of the southern districts about Penrith were of a similar nature. In Carlisle the trembling of the earth was distinctly felt in various parts of the city, preceded or accompanied by a loud rumbling noise resembling the sound of distant thunder, or of a cart rattling over a stony street.

About three minutes past 11 on Friday night a smart shock was experienced over the Lake district. The effect was sudden, and the agitation powerful. but of short duration. It was accompanied by a sound as if a heavy goods train passed at express speed, and the shock was followed by a rushing wind which quickly died away. At Kendal the first shock occurred about twenty minutes past 6 in the evening, but the most severe shock occurred at a quarter past 11, when the violent vibration of the earth occasioned great alarm, and people rushed half naked from their beds into the streets to ascertain the cause. At Preston the shock was very keenly felt. At Bamber-bridge some of the houses were, it is reported, "shaken terribly;" at Walton-le-Dale walls, doors, &c., oscillated remarkably; at Ashton-on-Ribble the vibration was very strong. On the south-western border of Lancashire, ranging from Ormskirk to Longton, the shock of earthquake was most palpably felt, and it was accompanied with many of the noises and scenes before mentioned. Round the Fylde of Lancashire, and across it from Kirkham to Garstang, the shock was in several places experienced. In Blackpool and the neighbourhood the action of the earthquake was very violent in some parts, glass and crockery having been thrown off shelves and broken. At Leeds, York, Manchester, and Doncaster, the shock was variously felt. At Hexham it was preceded and indeed accompanied by a loud noise. The wave evidently proceeded from west to east, as the bed upon which the witness had slept was tilted on the west side first, and then on the east. The shock was felt in the whole of the lower part of the valley of Wensleydale and Swallowdale. The shock was from the north-west to the south-east. In North Yorkshire those who lived on the rock hills felt very little of the Friday night's shocks, but in the wide vales, which, from boring, are known to be filled for hundreds of feet with Kimmeridge clay, all the shocks were severe.—*Abridged from the Times.*

Mr. C. F. Valey announces the remarkable Fact that on the 17th of March, a few minutes before and after the earthquakes, powerful positive electrical currents were rushing towards England through the two Anglo-American telegraph cables, which are broken near Trinity Bay, Newfoundland. The French Atlantic cable and some of the English telegraphic lines were disturbed at the same time. These facts are curious and deserving of careful record. Without accepting or rejecting Mr. Valey's

hypothesis of "subterranean lightning," we would venture to ask if the "magnetic storm" theories are not sufficient to guide us for the present?

OFF MEXICO.

LIEUTENANT-COMMANDER FARQUHAR, commanding the *Kansas*, reports to the Department, off Minatitlan, Mexico, that two distinct shocks of earthquake, lasting about fifteen seconds, were recently felt in that vicinity. A wave about 1 ft. in height immediately followed. The sensation on board the ship was as if the vessel was pounding on rocks.

EARTHQUAKE IN HAWAII.

SANDWICH ISLANDS papers describe the Earthquake on the night of February 19 as the most severe shock remembered by any one living. The Honolulu *Gazette* says it came from the east. The *Commercial Advertiser* says:—"Immediately after the rumbling noise followed the shock, at first an up-and-down movement, short and quick. To this succeeded a series of horizontal jerks, sufficiently powerful to cause a perfectly sober person to stagger in attempting locomotion. This continued so long that the strongest-minded people began to ask themselves apprehensively, 'How much longer is this to continue?' And the naturally nervous and timid ones became terribly frightened. Some fainted outright, others went into hysterics, and one or two instances are reported of people falling upon their knees and praying fervently. The duration of the severe shock was about 30 seconds, and then, as the rattling of windows and doors ceased, the swinging movement of the earth succeeded. This with many produced a feeling of nausea, and some were affected to the extent of vomiting, with all the symptoms of sea-sickness. While the motion of the earth continued, the thousand dogs with which Honolulu abounds, were silent as the grave, but when it was over they set up a clamour of astonished yelps and howls from all directions. Almost every clock in town was stopped, though we have heard of one or two that were not, but on inquiry learnt that the pendulums of each swung east and west, which would corroborate our theory of the course of the earthquake wave." No great damage was done at Honolulu. A Correspondent of the *Gazette* on the island of Lanai says:—"This earthquake is declared by the oldest natives of the island to be by far the most violent and fearful ever felt by them on Lanai. The shock of April, 1868, was very light here, and barely noticed by a few; but this one roused up every soul on the island, shook it from vale to peak, and racked and rent its bold, rock-ribbed coast. A great portion of the well-known bluff, Pali Kaholo, has fallen into the sea; enormous fragments have broken off from those towering ocean walls between Mancle Bay and Kawaike Point; masses of the red basalt have been torn from the beetling turrets of Puupehe, the lone sea-tower near the south-

eastern end of the island; huge boulders have been hurled from the mountain sides, and the ravines are filled with *débris* of rocks and trees and slides of earth; several great clefts have been opened in different parts of the island, and it has been shaken and broken as though the mighty elements of the earthquake were surging and upheaving at its very foundations, and ready to burst forth with volcanic fury and convert its lovely valleys once more into flaming, sulphureous craters."

Another account states:—"Shocks of earthquake occurred on February 19, in the Hawaiian Islands, and were general throughout the group. In Lausl great rocks were hurled down from cliffs, and some of the valleys were rendered incapable of cultivation by the *débris* from the mountains. Great wonder is expressed that no lives were lost on any of the islands. At Honolulu the shocks commenced at 10.7 P.M., were three in number, and followed in rapid succession, lasting altogether over one minute At the other islands the time was different, the last shock occurring at Lahiva at 11.24 P.M."

VOLCANOES IN CALIFORNIA.

In remote ages California was the scene of great volcanic activity, especially the northern part of the State, for no lavas or volcanic peaks west of the summit of the Sierra Nevada have been found south of the latitude of the Golden Gate, while on the other side of that line they are very abundant. Mount Diablo has the general shape and solitary position of a volcano, but its rocks were deposited in water, and not thrown from beneath in a molten condition. The numerous high peaks of the Californian Alps—the principal one reaching the greatest elevation in the United States—much as some of them resemble volcanic cones at a distance, fail to show any signs of volcanic action, so far as they have been closely examined. Many of the lava beds of the Sierra Nevada are prominent features of the landscape, because, being harder than the adjacent rocks, which have been washed away to a considerable depth, they have been left standing as mountains 500 or 1,000 feet above the general level of the country. On the coast, the most southerly volcanic peak yet discovered is St Helena, the summit of which is 4,343 ft. high, and 8 miles distant from Calistoga. The volcanic character of the formation is unmistakable; but so many centuries have passed since its activity ceased that there is nothing in the form of the mountain like a crater. The basaltic columns found at its summit, and also on the mountains east of Napa Valley nearly to the bay, were crystallised from lava that must have flowed from near the summit of St. Helena. But whence came the lava that crowns the ridge between Sonoma and Petaluma? Two valleys separate that ridge from St. Helena, and no other volcanic cone in the vicinity is known to the general public. And whence came the volcanic tufa that forms a large

part of the mountain between Napa and Sonoma? And whence a similar body of tufa found on both sides of Green Valley, in Solano county, extending down across the line of the California Pacific Railroad, which passes through it by a short tunnel? To all these questions we have no solution, nor do we find any solutions in the report of the State Geological Survey. Some of this tufa, found at Green Valley, is an excellent building stone, soft enough to be cut easily, hard enough to bear a great weight and to last for ever, almost fireproof, and handsome in its grey and light red colours. But the chief interest of this tufaceous rock is due just now to the existence in it of the largest known collection of petrified trees, one of them 7 ft. in diameter and another 5 ft. Usually petrified wood is found in small isolated pieces underground by miners and excavators; but here we have a number of large trunks lying on the surface of the ground and conveniently accessible. Clear Lake was the crater of an immense volcano, which may have sent much of its erupted matter southward toward Suisun Bay, and several of the high peaks of the Coast Range further north are probably of volcanic origin; but we do not find that our geologists have recognised a volcanic character in their formations. The lava and mud that poured out from St. Helena, and, perhaps, other neighbouring volcanoes, ran down almost to the shores of San Pablo and Suisun Bays, and there halted; so that we look in vain for their concomitants of basaltic columns and large petrified trees in the mountains south of the Strait of Carquinez. The north and north-eastern parts of the State were the chief centres of activity in the volcanic era. Shasta and Lassen Peaks owe more than a mile each of their elevation to the matter that was thrown from their own craters, and their lava covered hundreds of square miles, and has not yet been disintegrated enough on the surface to give vegetation much of a chance to beautify the landscape and fertilise the soil about them.—*San Francisco Alta.*

VOLCANO AT TERNATE.

The *Batavia Handelsblad* of September 25 publishes the following particulars of a volcanic outbreak at Ternate:—"On the afternoon of August 7 a violent earthquake was felt, of which the exact direction was unknown. The Ternate mountain had from 9 A.M. caused a dull rumbling sound to be heard, varied at intervals by loud reports, and began in the course of the day to cast out streams of lava. The sky looked dark, and the whole country round about was darkened by the down-coming smoke clouds. Luckily, a southerly wind sprung up, which gave another direction to the glowing lava streams flowing landwards, and led the fire in seven currents to the ravines This frightful natural phenomenon held on during the night between the 7th and 8th. The inhabitants, thinking their island to be doomed, could not sleep, and passed the night outside their houses. At

daybreak the outbursts became worse still; the population began to fly to the islands of Tidore and Halmaheira. All the Tidorese or Ternate fled back to their island, accompanied by thousands of other runaways. The Chinese were the first to seek their safety in flight. The casting out of fire and stones held on for about 12 days, after which it became less." The *Java Bode* of September 19 states that this outburst was the most violent known at Ternate within the memory of man. There were only some slight earthquake shocks felt. On August 28 the volcano was out.

VOLCANO AT CAMAGUIN.

GUSTAV WALLIS writes from Manilla, May 24.—A volcano has burst forth from the island of Camaguin. For some months previously the inhabitants of this island, as well as those of Bojot and Cebri, had been alarmed by repeated shocks of earthquake. Camaguin had been gradually deserted by most of its inhabitants, although the fugitives found their position in the neighbouring islands little less perilous, every district having been more or less affected by the heaving of the ground. At last, on May 1, about 5 o'clock in the evening, a rumbling like thunder was heard from a mountain near the village of Catarmin, interrupted by a few violent shocks which rent the air with reverberations, and which steadily increased in strength until at last the ground burst asunder and an opening was left 1,500 feet long. Smoke and ashes, earth and stones, were thrown up and covered the surface of the ground far and near. Then succeeded a long pause, and about 7 o'clock, as darkness was approaching, the explosion came, followed by a shower of fire. Sad to say, about 200 persons who had thoughtlessly collected round the crater, were buried under the matter which fell.

THE SUPPLY OF COAL.

THE Royal Commissioners have published the result of their ten years' labour—the Report and Sub-report of their inquiries into several matters relative to Coal in the United Kingdom, filling three large volumes. It is impossible to condense this vast question into the small space we can devote to it; and it cannot be perfectly understood without such treatment. In the *Times* have appeared three very able papers upon our Coalfields and the supply, from which source the following quotations are selected:—

The Commissioners had to find answers to six great questions, which may be shortly put:—

1. "What is the depth to which it is possible to follow coal?" To this they answer, "About 4,000 ft., because of heat." At 50 ft. below the surface the temperature is constant at 50 deg., winter and summer, so far as can be ascertained, in our country.

Thence the rate of increase is pretty constant, and is one degree for each 60 ft. in our coal mines. In the deepest English mine, at Rose-bridge, at 2,419 ft. the temperature is 94 deg. At this rate, at 4,000 ft., it will be about 105 deg. In the hottest English mine, which is in Cornwall, and is heated by a hot spring, the temperature is sometimes 123 deg., and the air is saturated. Men work there for short spells of 15 minutes, and work only during three hours in 24. It is manifest that coal would be dear if got from 4,000 ft. under like conditions.

2. "What is the attainable quantity of coal in our known coal-fields?" Taking 4,000 ft. as an attainable depth, they answer 90,207 millions of tons, after making all deductions.

3. "Is it probable that coal exists at workable depths under rocks newer than the coal measures?" Taking the same limit, making the same deductions, and reasoning upon geological *data*, they answer, "Yes," and, further, they point out where coal may be sought with certainty, or with more or less probability of success. In the General Report is a tabular estimate of quantities which may hereafter be made available, and the quantity returned is 56,273 millions of tons. The evidence upon which this estimate is founded, the details, and the maps, ought to interest residents in the districts named. Reporters further point to districts in which coal exists at depths greater than 4,000 ft., and to areas within which it is probable that coal may hereafter be found. The whole amount returned as available is 146,480 millions of tons of coal at depths less than 4,000 ft. allowing for all deductions, and 41,144 millions of tons between 4,000 ft. and 10,000 ft., which may all become available when men have learnt to live and to work where water boils. Besides all these quantities we may, or we may not, find more in the south of England, but meantime the Commissioners report that there are 146,480 millions of tons of available coal.

Many fondly imagine that coal grows underground. It does not grow there, and it will not grow in a cellar "Wilful waste makes woful want," as the proverb has it. Every householder can understand that the coal in our national cellars will come to an end sooner or later, and that the end will come sooner if the coal is spoilt, or wasted, or used extravagantly.

1. If 100 sacks of coal are in the cellar, and one sackful is regularly burnt daily, the last sackful will be emptied on the 100th day, by simple substraction or by division.

2. If the coal is used up at a rate increasing extravagantly, and arithmetically by a fixed daily quantity of say one daily sack, thus—

Daily sacks—1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
Totals daily—1, 3, 6, 10, 15, 21, 28, 36, 45, 55, 66, 78, 91, 105

—then the store will not last out the fortnight.

3. If the rate increases recklessly, ruinously, and geometrically thus—

Daily sacks—1, 2, 4, 8, 16, 32, 64
Totals daily—1, 3, 7, 15, 31, 63, 127

—then 100 sacks in store on Sunday will not last out the week. More than three months, less than a fortnight, or less than a week are notable differences in duration of coal available for use in a cellar.

4. If the rate be supposed to wax to extravagance and wane to parsimony, the 100 sacks need never end, for the last sackful may be halved for ever—1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, 1-16th, 1-32nd, 1-64th, and so on. But in these later days pounds and half-pounds, pinches and half-pinches of coal dust will make sorry fires, unless the extravagant household learn from the pinching of want to make their daily allowance of pinches do the work of the profuse old wasteful allowance of prosperous times.

These are simple sums, but applicable to all quantities; and by simple sense, it is probable that our national coal cellars will be emptied upon some waxing and waning rate, as suggested by Mr. Hull ten years ago. In this sense coal is practically inexhaustible, but it must soon become dear if consumption continues to grow geometrically, as it has since 1855. The Report shows what the rate of increase has been. In 1660 the coal produce was two millions of tons; in 1800, ten millions; in 1865, 64 millions; in 1869, 107 millions. In this year it will be about 115 millions. If the whole earth were coal, all available, and all our own, we should exhaust the supply in a short time by geometrical progression. Mr. Hull suggested short time; so did Mr. Jevons. The Commissioners state facts. But what is the mistress of this extravagant household to do? Thriftlessness brings ruin. Is she to publish truths which her loyal Royal Commissioners humbly present to her, and leave posterity to learn economy from ancestral waste, or is she to set the rulers of her house to contrive regulations for the coal cellars down below and the fires upstairs?

4. Is coal wasted in working? The Commissioners answer, "It is." In some mines ten tons or less are lost in getting 90 or more out of the ground for use; but 40, 60, or more are commonly wasted in getting 60, or 40, or less out of a seam. Some seams are left where they will never be got at again. That is well known to all who are concerned in coal mines. The Commissioners who reported on quantities generally allow 30 per cent. for loss in estimating quantities available for use. If waste can be lessened, the available store will be increased by so much. It is notorious that coal is worked for profit, without the smallest regard for posterity. Is posterity to be considered or not?

5. Is coal wastefully used? The answer is, To a considerable extent, but not so much as formerly, when coal was profusely wasted. If this waste can be lessened, the value of our available store will be increased, and it will last all the longer, or do more useful work. Where all this waste exists there is room for re-

form. That is plain; but is it worth our while to reform, having all these millions?

6. Is the ascertained rate of consumption likely to increase? Suppose that the rate will increase, then the present holders of the national coal-cellars—landowners, and their lessees, and their heirs—ought to consider whether their property is being used extravagantly, wastefully, or economically, so as to injure the next heirs or remainder men, for the sake of life tenants, or "how otherwise."

Having reported the quantity of Coal available for use, the problem left for solution is—How long will it last? Taking the rate of consumption chosen by Mr. Jevons, the coal now reported to be available will last 110 years.

Using an arithmetical rate of progression founded upon fact, it will last 277 years.

Taking a geometrical, diminishing, progessive rate founded upon Census returns, &c., it will last 360 years.

Dividing the sum by 115 millions of tons, which is about the consumption for the current year. it will last about 1,300 years.

By other calculations we can get other results, but we cannot know futurity.

That was and is the real Coal Question.

Adopting 4,000 ft. as the limit of practicable depth in working, and accepting the estimate of each Commissioner for the waste and loss incident to working the coal in the district assigned to him, the Commissioners proceed to present a summary of the results of the reports obtained by them relating to the several coalfields. These reports supply the following e timate of the quantities of available coal Amount of coal in statute tons to depths not exceeding 4,000 ft., and after the necessary deductions:—In England and Wales, 80,208,139,468 tons; in Scotland, 9,843,465,930 tons; in Ireland, 155,680,000 tons; making a total of 90,207,285,398 tons. Amount of coal at depths exceeding 4,000 ft., and after the necessary deductions·—In England, 7,320,840,722 tons, viz., above 4,000 millions in South Wales, nearly 1,900 millions in Bristol district, above 1,000 millions in North Staffordshire, 234 millions in the Midland district, 90 millions in Lancashire and Cheshire. Grand total of coal in known coalfields in the United Kingdom, 97,528,126,210 tons. The following are the estimates of coal in England and Wales to depths not exceeding 4,000 ft:—South Wales, 32,456,208,913 tons; Forest of Dean, 265,000,000 tons; Bristol, 4,218,970,762; Warwickshire, 458,652,714; South Staffordshire, Coalbrook Dale and Forest of Wyre, and Clee-hills, 1,906,119,768; Leicestershire, 836,799,734; North Wales, 2,005,000,000; Anglesey, 5,000,000; North Staffordshire, 3,825,488,105; Lancashire and Cheshire, 5,546,000,000; Midland, 18,172,071,433; Black Burton, 70,964,011; Northumberland and Durham, 10,036,660,236; and Cumberland, 405,203,792— total, 80,208,139,468 statute tons. The Commissioners to whom the districts were assigned were instructed to

exclude from their returns all beds of coal of less than one foot in thickness.

A tabular statement shows 56,273 million tons in all, nearly the whole of it in England and Wales, there being, in fact, no estimate for Scotland. 23,000 million tons are in Yorkshire, Derbyshire, and Nottinghamshire; 5,800 millions in the district between South Staffordshire and Shropshire coalfields; 4,580 millions between South Staffordshire and Coalbrook Dale coalfields to the Cheadle and North Staffordshire; 3,400 millions between the Warwickshire and South Staffordshire; 2,494 millions in Warwickshire; 1,790 millions in Leicestershire; 2,489 millions east of the Denbighshire coalfield; 1,500 millions west and south-west border of the North Staffordshire; 1,850 millions in Cheshire; 7,233 millions in Lancashire; 1,593 millions Vale of Eden; 33 millions in Ingleton and Burton; 400 millions Severn Valley.

In order that the vast magnitude of our stores of coal may be better appreciated, 146,480 million tons would support our present consumption (at 115 millions per annum) for 1,273 years; would support a production of 146 millions for 1,000 years; of 175 millions for 837 years; of 230 millions, being double our present production, for 636 years The question of the duration of the total available quantity turns chiefly upon the statistics of consumption contained in the report of Committee E, from which the following facts are collected:—In 1660 the coal produce of the United Kingdom appears to have been only about two and a quarter million tons; in 1750 it had increased to nearly five million tons; in 1800 the quantity exceeded ten million tons. About this time the system of canal navigation was rapidly extending, and coals were gradually finding their way into new districts and the consumption greatly increasing. In 1816 the production reached 16 million tons, according to one statement, and 27 millions as given with considerable probability by another. In 1854 the production exceeded 64 million tons. In 1869 the quantity raised in Great Britain exceeded 107 million tons, and 97 millions were retained in the country for home consumption, approaching four tons per head.

Of the Commissioners, Mr. George Eliot agrees to the report, except as to the introduction of that part of the calculation by Professor Jevons which seems to imply the possibility of the exhaustion of our coal mines in 110 years. Sir Roderick Murchison writes:—"Although I agree with my brother Commissioners as to the greater portion of the report, I beg to record my earnest protest against the statement made upon the probable existence of coalfields under the cretaceous and other secondary rocks in the south of England. That view, being purely theoretical, is, is my opinion, distinctly controverted by the evidence of physical data all around the area in question, whether in England or France. For wherever rocks of carboniferous or older date are there found in contact with younger deposits, such older rocks are

everywhere unproductive of coal. I am therefore of opinion (and many well-known practical mining geologists agree with me) that the existence of any productive coalfields in the south-eastern counties of England is in the highest degree improbable."

THE FORMATION OF FLINTS.

MR. M. HAWKINS JOHNSON has read to the Geologist Association a paper "On the Origin of Flints, and the Process of Silicification in general." After briefly alluding to the different positions in which these substances occur, the author proceeded to show that their formation is due to a chemical process, which may be roughly expressed in chemical language as the substitution of silicon for carbon. He pointed out how a crop of sponges invested with their gelatinous flesh or sarcode, and living on the bottom of a deep ocean, were suddenly buried in a thick stratum of white mud, and consisting of the minute shells of *foraminifera*; that they then dried, and while in the process of decomposition this interchange of materials took place, the nascent carbonic acid parting with its carbon in exchange for the silicon of the silicate of soda, which sea-water is known to contain.

At the close of the paper the author produced a tadpole upon which he had experimented, and which he had that afternoon subjected for two hours and a half to the action of nitric acid, and without its undergoing any alteration, the inference being that the animal had become invested with a film of silica of sufficient thickness to protect it from the acid: and another tadpole, that had not undergone the same preparation, having been converted into a brown cloud by immersion in the acid for the same time. Some further experiments should be made in this direction. The importance of being able to protect perishable surfaces from decomposition is very great.—*Builder.*

STONE-IMPLEMENT AGES IN ENGLAND.

MR. J. W. FLOWER has read to the British Association a paper "On the Order of Succession of the several Stone-Implement Ages in England" The author stated that—

"It has been usual to consider the stone age in England as divisible into two periods only—the Palæolithic and Neolithic. Although in works embracing so wide a scope as those of Sir Charles Lyell and Sir John Lubbock it would probably have been inconvenient to adopt any less general arrangement, it seemed to be hardly adequate for scientific purposes as regards England, since there could be no doubt that the drift implement period in England and France was separable from that of the caves, as that of the caves was removed from the tumulus or barrow period, by an interval of vast but incalculable duration. It was clear that the drift implement gravels were deposited before the sands and gravels which overlie them, occasionally to the depth

of 20 ft. or 25 ft., were deposited; that the deposit in all probability preceded the severance of England from the Continent, and it was not unlikely that it was anterior to the emergence of the north of England and all Scotland from the waters of the sea which deposited the boulder-clay, inasmuch as the implements were never found north-west of a line drawn from the Severn to the Wash; and further, it was evident that if these gravels had been brought to their present position by means of rivers, those rivers must have derived their waters from other catchment basins, and have run in other channels than those ot any existing rivers, since no existing rivers could possibly have carr ed the gravels to the places in which they are now seen. The archæological or technological conditions of the drift and the cave periods were also so entirely different as to indicate the lapse of a very long interval of time. While (with one exception only) no drift from out of 15 or 20 varieties had ever been met in the caves, the caves presented various stone implements and weapons, as well as instruments in bone and horn, not one of which had ever been met with in the drift, while as regards palæontological conditions a very wide difference was observable between these periods Only six genera and seven species of mammals had yet been found in the drift, whereas the caves presented no less than 21 species (in one instance 27), comprising several important forms quite unknown to the drift, including elk, lion, wolf, beaver, hyena, and, with one somewhat doubtful exception (the cave boar), exhibiting the first appearance of the carnivora and rodentia in the post-glacial fauna. As between the cave period and the tumuli, no geological distinction, or hardly any, was observable, but the palæontological evidence was irresistible. All the great pachyderms of the caves had now entirely disappeared, and were succeeded by an entirely new fauna, comprising the dog, rabbit, pig, sheep, and ox. An enormous period must be allowed for the extinction of a large and important fauna and the creation, or, as some might think, the evolution, by some kind of selection, of one entirely new. The archæological or technological difference between the caves and the tumulus period was also significant and important. Flint was still in use, but usually in very rude and coarse forms, and now, for the first time, as it would appear, in England, bronze made its appearance. Some polished flint and stone celts had been found in barrows—three or four probably out of several hundred instances; but from various indications these, probably, should be attributed to secondary interments and a later period. The polished axe-hammers often found in barrows were probably imported, as the bronze may have been. They were made of stone not usually found in the country, and were of very superior workmanship, whereas the native flint implements were extremely rude. The presence of these axes could hardly be held to constitute what should be called a polished stone age. With regard to the polished or neolithic stone period,

although there was no means of ascribing any precise date to these objects, there seemed good reason for concluding that the English forms were posterior in date to those of the tumuli, as they are not only of a far more expensive and elaborate style of workmanship, but they are not unfrequently found associated with works of art of a superior kind, and sometimes, although rarely, they have even been found with Roman coins. Upon the whole, it seemed that the drift cave forms could not properly be placed in the same category under the title palæolithic; and, as it is inconvenient to multiply terms, Mr. Flower suggested that the former might be known as palæolithic, and the latter as archæolithic (an alternative term proposed by Sir J. Lubbock). The implements found in the barrows might very well be known, as Mr. Boyd Dawkins suggested with regard to the fauna of that period, as prehistoric, while the polished flint implements might be still designated as neolithic. We should thus have four stone-implement periods instead of two, and the English bronze age might very well be considered contemporary with the last two, if, indeed, not anterior to the latest."

Mr. Pengelly said he was inclined to think that the suggestion Mr. Flower had thrown out of a four-fold instead of a two-fold division of the flint implements might be of convenience; but the implements might be contemporary, although representing different states of civilization. In a retired part of the country there might be a rude kind of implement contemporary with a more highly wrought kind in another part of the country.

CRUISE ROUND THE WORLD.

Rear-Admiral Hornby's Cruise Round the World with six of Her Majesty's ships, the *Liverpool*, *Liffey*, *Endymion*, *Scylla*, *Barrosa*, and *Phœbe*—took him 515 days from England, and he was at sea on the whole or part of 409 days. He left Plymouth Sound on June 19, 1869, and after touching at Madeira on July 1, reached Bahia on August 2, and making his way under sail with light winds and calms, anchored in the harbour of Rio de Janeiro on August 16. Here some refitting was done, and provisions were completed. In accordance with the request of the British Minister at the Brazilian Court, general leave was not granted. The Emperor held a special *levée* to receive the officers, and visited every ship. On the 25th the squadron left Rio, met with very thick weather, and on September 6 anchored in the River Plate, off Montevideo. The *Barrosa* had a case of yellow fever on the passage, that of a boy who, attempting to desert at Rio, concealed himself in a merchant ship in the harbour, and there contracted the fever, which ended in his death. Having completed the gunboats in the River Plate with provisions, the squadron left on September 11 for the Cape of Good Hope. Westerly winds of varying strength were experienced, sometimes enabling the squadron without steam to

cover 250 to 260, and once 280 knots from noon to noon. The squadron anchored in Simon's Bay on October 3, and underwent a large refit. General leave for three days was given, and though many of the men had not had any since leaving England, their conduct was so good that the Mayor of Cape Town expressed the satisfaction of the inhabitants to the Rear-Admiral. The squadron left on October 16 under sail for Melbourne; the passage was the most boisterous one that was experienced. Anchor was cast in Hobson's Bay, Melbourne, on November 26. General leave for two days was granted, and too many of the crew never found their way back; the reception of the squadron was most hospitable and enthusiastic. On December 7 Melbourne was quitted, and on the 13th Sydney was reached; the shores of the harbour were lined with dense masses of people, and a general holyday had been proclaimed. The squadron remained here 13 days, and there was a thorough refit of the ships. General leave for three days was given, and again the conduct of the crews was most satisfactory, except in desertions, which numbered 27. The Colonial Government sent a handsome present for the Christmas dinner of the ships' companies. On January 2, 1870, the squadron anchored in the Derwent, off Hobart Town, and stayed until the 10th. The visit was most welcome. Again leave was given. The run across to New Zealand was soon accomplished; Lyttleton was reached on the 18th, Wellington on the 24th, Auckland on February 2. Thousands visited the ships at these places, and the effect of the visit was excellent. A careful estimate showed that from the arrival of the squadron at Melbourne to its departure from Auckland about 23,937*l.* was spent by the officers and crews, and in the purchase of provisions and stores for the ships. On February 9 the squadron left New Zealand for Japan; between the Minerva Rocks and Ualan Island, the sea being little frequented, and said to contain unknown reefs and shoals, the ships occasionally had to be sailed at night in single column. They anchored at Yokohama after a passage of 56 days. From 28° south to 22° north latitude the thermometer by day never stood below 80°, and generally was as high as 82° to 86°. The squadron proceeded up the Gulf to Yedo, and His Majesty the Mikado held a special *levée* to receive the officers. The leading members of the Supreme Council visited the flagship. At the desire of the Japanese Government two Japanese naval cadets were received in the squadron for the purpose of acquiring some knowledge of naval service, and the internal economy of our men-of-war, the expenses being paid by the Government of Japan. One committed suicide while under monomania, the other made very satisfactory progress, and entirely adopted European customs. Sir Harry Parkes declared the visit of the squadron beneficial in a public sense. The passage from Japan to Vancouver's Island was trying; bitterly cold, thick, and stormy weather was experienced. The calendar was altered on passing the meridian of 180° by the intercalation

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of a second Tuesday, May 3. Esquimault Harbour, Vancouver's Island, was reached on May 15. Leave was given, with the usual result of some desertions, American territory being so near. The squadron left on May 28, after refitting and taking on board invalids from the Pacific squadron for England. Honololu was reached on June 16, and quitted on the 23rd; the King of the Sandwich Islands paid a visit to the squadron. The equator was crossed on July 4; and no steam being used, Valparaiso was not reached until August 14, after a most monotonous passage of 52 days, on 50 of which not a speck of land or a vessel was seen. While here, repairing and refitting, news was received of war having broken out in Europe, and orders came to return to England at once. The squadron left on August 28, and met unfavourable winds and heavy seas. Anchor was cast in Plymouth Sound on the morning of November 15 last, after a cruise of upwards of 52,000 miles in less than 17 calendar months. The foreign stations visited were reinforced with 264 supernumeraries carried out in the squadron, and several men were spared to fill up vacancies in ships met with. Time-expired men were brought home. The squadron was essentially one of instruction, and training received especial attention. Advantage was taken of every opportunity, in the fine weather passages, to exercise the squadron in fleet manœuvres. The average number of persons borne was 2,605. 3,461 tons of coal were expended.

GOLD-WORKING.

MR. C. WILKINSON has announced to the Royal Society of Victoria that gold, when placed in a solution of its chloride undergoing decomposition by contact with organic matter, determines the deposit of much or all the liberated gold upon itself. This fact, first observed by Mr. Daintree, he assumes as accounting for the formation of nuggets Mr. C Wilkinson also found that copper, iron, and arsenical pyrites, galena, zinc blende, stibnite, wolfram, and molybdenite also act as nuclei for gold thus reduced, but that brown iron ore and quartz do not. These results have been verified by a critical enquiry conducted by Mr. C. Newberry, analyst to the Geological Survey.

Astronomy and Meteorology.

THE ROYAL OBSERVATORY, GREENWICH.

At the Annual Visitation of the Greenwich Observatory, in addition to the ordinary instrumental features of the institution there were shown the instruments and portable observatories which have been prepared for observations of the transit of Venus in 1874 at the various stations on the earth at which it has been decided to locate British observers. There was also shown a telescope filled with water which has been specially prepared to solve an intricate astronomical problem connected with the aberration of light.

LUMINOUS METEORS.

Mr. Glaisher has read to the British Association the "Report of the Committee on Luminous Meteors," the object of which was to indicate the progress of meteoric astronomy during the period that has elapsed since the report. A number of valuable communications on the appearances of luminous meteors and regular observations on star showers have been forwarded to the Committee in the course of the year. The heights and velocities of 13 shooting stars, obtained by the co-operation of Mr. Glaisher's staff at the Royal Observatory, Greenwich, during the watch for meteors on the nights from the 5th to the 12th of August last, are sufficiently accordant with the velocity of the Perseids, as obtained by similar means in the year 1863, to afford the satisfactory conclusion that the results of direct observation are in very close agreement with those derived from the astronomical theory of the August meteor shower. On the mornings from the 13th to the 15th of November last a satisfactory series of observations of the November star-shower (as far as its return could be identified), recorded at the Royal Observatory, Greenwich, and at several other British stations, concurs with very similar descriptions of its appearance in the United States, in showing the rapid decrease of intensity of this display since the period of its greatest brightness in 1866 and 1867. Notices of the appearance of more than 20 fireballs and meteors have during the past year been received by the Committee. Fourteen of the former were compared to the apparent size and brightness of the moon; and the latter include three detonating meteors of the largest class. Descriptions of some of the largest of these meteors were given in the report and its accompanying list. No notice of the fall of an aerolite during the year has been received, although the occurrences of large meteors during the autumn and spring months were unusually frequent. The locality of one of these, which appeared with unusual brilliancy in the south of

England on the evening of February 13, can be determined, at least approximately, as also the elevation of its flight. A table of the heights of 16 shooting stars doubly observed in England during the meteoric shower of August 1870 (independently of the observations recorded at the Royal Observatory, Greenwich), appeared in the last volume of the Association Reports. A comparison of the observations made at the Royal Observatory, Greenwich, on that occasion, with those recorded at the other stations, enables the paths of 13 meteors (ten of which are new to the former list), seen by Mr. Glaisher's staff, to be determined; and the heights and velocities of the meteors thus identified are entered in the report. The results are as follows: —The average height of 16 meteors (referred to in the last report) was 74 miles at first appearance, and 48 miles at disappearance; of 13 meteors (given in the present list), 72 miles at first appearance, and 54 miles at disappearance; of 20 meteors (observed in August 1863), 82 miles at first appearance, and 58 miles at disappearance. Present average heights are thus somewhat less than those observed in 1863, but they agree more closely with the general average height at first appearance—viz., 70 miles; and that at disappearance—viz, 54 miles. The average velocity of the Perseids (relatively to the earth), observed in the year 1863, were 34 miles per second, and that of the three Perseids in the present list was 37 miles per second; while the velocity which Professor Schiaparelli obtained from the cosmical theory was 38 miles per second. A considerable shower of shooting stars was also noted on the night of April 20 last, for which preparations were made, which were attended by satisfactory results. The report, which was very elaborate, also contained a discussion of the new meteor showers noted during the last few years by Professor Schiaparelli, agreeing, in many points, with previous conclusions drawn by the Committee from observations contributed to the British Association, and suggesting considerations of novelty and interest in relation to their probable explanation.

THE AUGUST METEORS OF 1871.

M. Leverrier, member of the French Institute and President of the French Scientific Association, has established through that society 25 temporary observatories, with a staff of competent observers properly trained and supplied with special maps and chronometers. Telegraphic signals were exchanged between the different stations for the reduction of observations. The observers, more than 200 in number, kept a regular watch during the three critical nights 9.10, 10.11, 11.12 August inst. Some of the stations had the view of a clear sky, but by far the greater number were disturbed by cloudy or stormy weather. Some of the observers were satisfied with giving the numbers of meteors actually visible; some others rejected every apparition which

had not been recorded on the maps. An ulterior discussion will be worked out, but the following numbers, even in their crude state, might be considered as bearing a general interest:—Bordeaux has seen 362 stars; Chartres, 980; La Guerche, 197; Le Mans, 200; Limoges, 217; all of them had their paths registered on the map; Marseilles, 448, partly registered; Montpellier, 973; of these 321 were registered on the maps; Poitiers, 650; St.-Honorine, 306; Toulouse, 136; St.-Lo, 619; Tournay, 910; Paris (Belleville), 775. No number has been given for the National Observatory, which is not in connexion with the association. Lyons, 80; all of them mapped; Barcelonette, 650; that station was the most promising, M. Barelly, the celebrated Marseilles observatory astronomer, having been despatched thereto; but the observations were much disturbed by a storm raging in Piedmont. At Genis 1,696 stars were seen; no special account has yet been given; only a telegram received. At Agde 301 stars were seen; at Laressore, in the Pyrenean district, 250; at Nice, 200, at Toulon, 189; more than 10,000 in total. These falling stars were generally very small, greatly inferior, most of them, to Capella. They were mostly coming from Perseus, but some of them were seen coming towards it. In some places, as Agde and St.-Lo, the apparition can be said to have been in some respects spasmodic. The coming of numerous meteors from the same part of the heavens was followed up by a period of absolute calm. Some of the meteors were following the same path at a very small distance indeed in degrees and in times. Very few were leaving behind them a visible track. But two exceptions are to be noticed. August 10, 11h. 2m.—Southern apparition, twice the brilliancy of Venus, duration, 1-6th sec.; strong whitish light, similar to an electric spark, seen at Angers. August 11, 1h 32m. 49s., seen at Tremont. A. R. 235 deg., P.D. 29 deg., burst with a strong red light, A.R. 233 deg., P.D. 39 deg.; left a luminous track, visible during 33 sec. The night August 10.11 was decidedly the time for the greatest brilliancy of the meteoric display. Time of *maximum* was at Angers from 1 to 2 in the morning on August 11, with 65 stars seen in that time; at Barcelonette, from 2 to 3 in the morning; 84 stars were seen during that time. According to St-Lo observers the radiant point was situate between α β Persei for the first night and γ δ of the same constellation for the second night. For the third night it could not be determined. As far as it can be ascertained from preliminary disquisitions, the Polar star has a radiant of its own, less important by far than Persei ambulatory radiant

Mr. W. F. Denning, of Cotham Park, Bristol, has communicated to the *Times* the following:—Meteors having been expected to be numerous during the last few evenings, a careful watch was maintained, and the following are the numbers that have come under observation:—

	H. M. H. M.	NO.		H. M. H. M.	NO.
August 9,	11 30 to 12 0 . .	7	August 11,	10 35 to 10 50 . .	18
„	12 0 — 13 0 . .	27	„	11 0 — 12 0 . .	29
„	13 0 — 14 0 . .	8	„	12 0 — 12 15 . .	16
„	14 0 — 15 0 . .	21	„	12 15 — 12 30 . .	15
August 10,	10 0 — 11 0 . .	17	„	12 30 — 13 0 . .	28
„	11 0 — 12 0 . .	27	„	13 0 — 13 15 . .	11
„	12 0 — 12 30 . .	27	„	13 15 — 13 30 . .	14

The majority of the meteors observed, especially those on August 9, were exceedingly small, and many of them were scarcely discernible. Several brilliant ones were, however, observed. At 12.23 on August 10, one of great lustre, and star-like in appearance, diverged from Perseus towards the horizon. It was of a blue colour, and left a trail of light, marking its path, which endured for about four seconds. At 10.44 on August 11, another brilliant one was witnessed. It was about equal to Venus, and was visible in Ursa Minor. The train which it left remained perceptible for a few seconds. It was, however, at 12.50 on the latter date that the most brilliant meteor was observed. It passed between the fourth magnitude stars Epsilon and Zeta in Cygnus, and soon afterwards disappeared, leaving in its flight a train which could be seen for about 7 seconds after the extinction of the meteor itself. This one, like the great majority of those observed, radiated from a small star B Camelopardali, situated at R. A. 48 deg. 37 min., and N. D. 59 deg. 18 min. There were several small ones seen in close proximity to this point. Not many were observed to come from other directions. One instance may be adduced. At 11.25 on August 10, a rather brilliant one passed from the bright star Scheat in Pegasus to Cassiopeia.

The majority of the meteors were accompanied with trains, which, however, were of very short duration. Most of the meteors seen were white, but several appeared of a light blue, and some of a yellowish colour. No sound was heard after the explosion of any one of them. They were more numerous on the 11th than on the 9th or 10th. The same fact was noticed in regard to the August meteors of 1869.

ON THE PLANETARY SYSTEM.

At a meeting of the Academy of Sciences of Paris, Mr. Charles Emmanuel has submitted a new series of experiments on Wafting Spheres, and expressed his belief that he had found the demonstration of his favourite theory. He says, in opposition to the opinions of all ancient and modern astronomers, that the real motion of the planets is from east to west, and the duration of the rotation of the earth, on itself, is equal to the solar and not to the sideral day. Mr. Emmanuel offers to further test his experiments in public.

NEW MINOR PLANET.

Dr. R. Luther, of the Bilk Observatory, near Dusseldorf, in a letter to the *Astronomische Nachrichten*, announces the discovery by him, on the evening of March 12, of what appeared to be a new Minor Planet. It shines as a star of between the 10th and 11th magnitude, and is therefore only a faint object, as, indeed, are all the minor planets that have of late years been found. Its position on March 12, at 10h. 59m. Bilk mean time, was ascertained by Dr. Luther to be—right ascension 12h. 1m. 11s., and declination north 7 deg. 46 min. And an observation made by Professor Argelander, at Bonn, gave for its place on March 15, at 12h. 13m. Bonn mean time—right ascension 11h. 58m. 36s., and declination north 8 deg 10 min. If not identical with the planet Camilla (discovered in 1868 but of which no sufficient observations were obtained to enable a proper orbit to be calculated) the object now detected is new, and by its discovery the number of known minor planets is increased to 113.

NEW PLANET

Professor C. H. F. Peters, of the Lichfield Observatory, Hamilton College, announces the discovery of a small Planet, the 114th in the group of asteroids, at 3 A.M. on July 25. It was observed in 21 hours 43 minutes right ascension, and 10 degrees 12 minutes south declension, having moved in 24 hours 45 seconds in the former co-ordinate, and 4 minutes and 20 seconds toward the south. Its magnitude is estimated between 12 and 13.

ENCKE'S COMET.

On Nov. 8, Encke's Comet was just visible to the naked eye as a faint star, but with an opera-glass it was plainly visible, and hazy, like a nebula It was a very clear night, and the zodiacal light was visible in the part of the sky opposite to the sun—that is to say, in Aries and Pisces.—*T. W. Backhouse.*

AËROLITE IN MAINE.

Professor Shephard, of Amherst College, Massachusetts, has published some particulars respecting the Meteoric Stone which fell at Searsmont, Maine, U.S., on May 21. About 8 A.M. there was heard an explosion, like the report of a heavy gun, followed by a rushing sound resembling the escape of steam from a boiler. The stone fell in a field, and a lady who was in a house close by saw the earth scattered in all directions as it entered the ground. The hole which it made was soon found, and on digging down the fragments were found still quite hot, the outside surfaces showing plainly the effects of melting heat. The largest piece weighed two pounds, and the fragments alto-

gether twelve pounds. They emitted an odour like that of flints when rubbed violently together. The hole made by the falling body was two feet in depth, the soil being a hard coarse gravel; but the fracture of the stone was obviously occasioned by its striking against three large pebbles, each about four pounds in weight. Professor Shephard obtained and examined the largest fragment of the Aërolite. Fully one-half of its surface was coated with the original crust, and the shape would seem to denote that the perfect mass had been of an oval subconical figure with a flattish base, so on the whole to have approached the shape of the famous Duralla stone, now in the British Museum. Among the constituent elements were found meteoric iron, peroxide of iron, chladnite, troilite, together with a single blackish mass which Professor Shephard considered was in all probability a plumbaginous aggregate.

AURORA BOREALIS AND SOLAR SPOTS.

Mr W. F. Denning writes from Bristol to the *Times*, Nov. 10:—"Last evening I witnessed a very interesting though not a very grand display of the Aurora Borealis. I first noticed the phenomenon at 7.30, when there was a large arch of auroral light extending from places about 45 deg. east and 45 deg. west of the northern horizon, and passing below Beta Auriga, through Ursa Minor, over the star Gamma, and passing on enveloped the stars Beta and Gamma in the head of Hydra. The light was most intense in the N.W. and N.E. Many changes were apparent in the intensity of this arch, and it soon appeared to be broken and gradually became much fainter, until at 7.57 P.M. all traces of the aurora had gone. I noticed no streamers at all, but at the time when the phenomenon was at its best an intense glow was suffused over the northern horizon. Much later in the evening, and indeed throughout the greater part of the night, this glow was still apparent through breaks in the stratus clouds that were situated in proximity to the horizon.

"It is interesting to note that at the present time some portion of the sun's disc is in a very disturbed state. I examined it this morning at 10.50 with a 4-inch reflector, and found that six spots of average dimensions were perceptible The largest one was the preceding spot of a group in the N.E. quadrant. The low power which I was using prevented my seeing any of the details of the appearance of the spots."

The Rev. J. Hoskyns Abrahall writes to the *Times* from Combe Vicarage, near Woodstock, Nov. 9:—"To-night about 7.30 I have happened to see here a striking manifestation cf the Northern Lights. A well-defined belt of gold, mounting more than halfway to the zenith, and resting on two broad pillars of the same hue, had spanned the whole of the north-western sky, its centre being above the Great Bear. Beneath lay a faint maroonish haze, through which gleamed the stars; below this, and above the

horizon, spread a but slightly defined arc of paler gold than that of the lustrous belt on high. In five minutes this grand girdle had vanished; yet for a short space it left at either end roundish halo-like fragments of itself, the effect of which was enhanced by some grim black cloudlets that sailed majestically over the scene."

The most remarkable auroræ observed by M. Renou, at Nairn, were those of the 24th and 25th of October, which were observed also at Paris. At Vendôme, in addition to its intensity, the phenomenon presented, according to M. Renou, the remarkable fact of the rays being curved to the extent of 5° or 6°. The barometer also fell 10 millimètres in an hour—an occurrence which M. Renou had never before observed in our latitudes. M. Deville remarked that the frequency of these auroræ appeared to have a certain coincidence with the severe winter; and there was nothing extraordinary in this, as it was well known that the phenomenon could only be produced when the atmosphere contained small ice-crystals.

ROARING OF THE AURORA BOREALIS.

The vexed question whether appearances of the Aurora Borealis are really ever accompanied by any loud noise seems to have been settled by M. Paul Rollier, the aeronaut, who last December started from Paris in a balloon, and descended, after fourteen hours in Norway, on Mount Ida, at an elevation of 4,000 ft. He says that he "saw through a veil of mist the brilliant rays of an Aurora Borealis, spreading all over its strange light. Soon after an incomprehensible and loud roaring was heard, which, when it ceased completely, was followed by a strong smell of sulphur, almost suffocating"

M. Bequerel read at one of the last meetings of the Academy of Sciences of Paris a paper on the Celestial Origin of Atmospheric Electricity, and he concluded by stating that the auroras result from discharges of this electricity, and thus M. Bequerel explains the roaring, more or less loud, heard by the inhabitants of polar regions. The greatest part of scientific men deny the occurrence of these sounds, but M. Bequerel, in support of his opinion, quoted the observations of Paul Rollier.

THE FATA MORGANA.

In a paper addressed to the Paris Academy of Sciences M. Wilfrid de Fonveille gives a description of the curious mirage, called the Fata Morgana, as seen near Edinburgh just prior to the great storm of June 18. On the day before strange rocks, changing their shapes, were seen coursing along on the surface of the water, appearing and disappearing by turns. Then followed green fields, trees laden with foliage and fruit, country houses, &c. The villages and seats situated on the northern shore of the Frith seemed to have advanced into the water; the

May lighthouse was invisible, but its base was transformed into a rock nearly 1,000 feet high. It would be worth while to ascertain whether other appearances of the fata morgana had ever preceded storms.

GREAT HEAT.

Mr. E. J. Lowe writes from Highfield House Observatory, Aug. 15:—"From the 6th of this month the temperature in shade has exceeded 80 deg. each day, being 89 deg. on the 11th, 89·4 deg. on the 12th, 90·9 deg on the 13th, and 81 deg. on the 14th and 15th, the *maximum* temperature in sunshine reaching 119 8 deg. On the 13th there was loud thunder from 3 P.M. to 5 P.M., and much lightning all the evening, more especially in the south. I was on Ben Lawes on the 11th inst., and there saw Loch Tay elevated in the air, at 2 P.M., about 1,000 feet, by mirage."

TYPHOON.

THE Typhoon of September 2 was very severely felt at Hongkong. It occurred at night, and the enormous waves appeared yet more gigantic from indistinctness, and sparkling throughout with the phosphorescent light of those seas, formed a spectacle of great grandeur Added to this was the picturesque appearance of the shipping, the only visible portion of which consisted of sombre hulls, and brilliant lights, now appearing for an instant, then hidden behind a giant wave, the dark hull rolling, the gay light flickering, at times dimmed by the intervening spray, and again shining out with a brilliancy sufficient to indicate to those on shore the position of the vessel. Throughout the earlier part of the night, especially during the flood tide the Praya was deluged, and the smaller craft were piled on the top of it with utter disregard to arrangement of any kind. The vagaries of some of these boats were curious. Opposite the Pottinger Street wharf, Inspector Grimes, who was coming down towards the harbour, was suddenly confronted by a great indistinct mass apparently bound for the Queen's Road at an astonishing rate of speed. He had time to get out of the way in an open doorway, and had the satisfaction of seeing the said mass, which proved to be a ship's gig, pass him like an express train. Similar effects were observed elsewhere, all the streets and ways leading down to the Praya being ultimately strewed with boats and the remains of boats. A boat in trying to round the corner of Messrs. Wahee, Smith, & Co.'s premises into Causeway Bay was capsized, and some of the crew, consisting of 12 persons, were with great difficulty saved; one old man and two children were washed away by the sea before the boat could reach them. The gale was at its height at 11 P.M. The destruction of boating in Causeway Bay was very heavy. One large Swatow junk was capsized opposite the residence of the sugar

boilers at the refinery, driving the head of her mainmast through the wall of the house. She was full of passengers, who were all rescued and kindly cared for; the poor fellows had lost their all in the wreck. The Praya in several places was completely demolished. Shops were unroofed everywhere. The loss of life was most serious at West Point, Wanchai, Aberdeen, and Sowkewan. But the full fury of the storm seems to have fallen on Macao. Here, it is stated, the barometer fell to 28·22 deg. The *Shanghai Budget* says that in the outer roads at Macao three of seven foreign ships were wrecked, and several of their crews drowned; and that in the harbour there were nearly 600 Chinese boats and junks, of which not 100 were left in the morning. A steamer next morning could hardly get in, owing to the mass of floating wreck in the harbour; at the Steamboat Wharf she found a mass of Chinese boats lying tier above tier. The *Budget* gives the estimate made that in all from 1,500 to 2,000 persons in and around Macao, ashore and afloat, lost their lives on this occasion.

LUNAR RAINBOW.

The Rev. G. R. Winter writes from East Bradenham, Thetford, Nov. 26:—"The evening was cloudy, and in the W. and N.W. were very heavy masses of clouds. Suddenly (it was about 5.35 P.M.) the moon, which was behind me, broke out with an intense brilliancy, and at the same time a very heavy shower of rain was falling, the end of the rain cloud just reaching me. The consequence was a most splendid rainbow. The arch was perfect, spanning the heavens in the N.W., and the colours, though faint, were distinctly visible So intense was the brightness that I distinctly saw the reflection of the rainbow. The contrast between the sky behind me and before was very remarkable. I hope this beautiful spectacle was seen by some more scientific observer than myself."

LUNAR PHENOMENON.

Dr. Burder, of Clifton, has communicated to the *Times*:—"A Lunar Phenomenon of extreme rarity and interest was visible here, April 25. At midnight the sky being crossed with long bands of filmy cirrus and generally hazy, I observed one particular line of light in the north-east, which, though it much resembled the adjacent streaks of cirrus, presented a curve too regular to be accidental. On extending my observation, I found that this line of light was a portion of an enormous halo, having the zenith for its centre and the moon in its circumference. It was, therefore, equi-distant from the horizon at all points, and the moon having at the time an altitude of about 33 degrees, it follows that the diameter of the halo was about 114 degrees. Although not visible throughout its entire course, it could be

traced with more or less distinctness through about three-fourths of the circle. There was present at the same time an ordinary lunar halo, with a diameter of 45 degrees, and within this the larger halo could not be seen. Two brilliant mock moons, with prismatic colours, appeared, one at either side of the moon, about three degrees beyond the inner margin of the smaller halo. Lastly, two other spots of condensed light (strictly mock moons) occupied positions in the larger, but corresponding, as I believe, to the points of intersection of a third halo, of which the moon was the centre and the radius 90 degrees. The two first-mentioned mock moons constituted the most conspicuous features of the phenomenon, their colours standing out with marvellous distinctness against a sky in that part fairly clear and black. The horizontal circle, although more interesting for its rarity, was not so striking as a spectacle, its light being comparatively dim, and its diameter too large to be included in a single view."

TOTAL ECLIPSE OF THE SUN.

THE earliest information of the Eclipse was received by Mr. William Huggins, and communicated to the *Times*, namely, a telegram from Colonel Tennant, F.R.S., who is in charge of the Indian Eclipse Expedition :—

"Dodabetta, Ootacamund, Dec. 12, 9.15 A.M.

"Thin mist. Spectroscope satisfactory. Reversion of lines entirely confirmed Six good photographs."

The sentence, "Reversion of lines entirely confirmed," refers to a very important observation made in Spain last December by Professor Young. This observation was described at the time by Professor Langley, one of the American party, in the following words :—

"With the slit of his spectroscope placed longitudinally at the moment of obscuration, and for one or two seconds later, the field of the instrument was filled with bright lines. As far as could be judged during this brief interval every non-atmospheric line of the solar spectrum showed bright, an interesting observation confirmed by Mr. Pye, a young gentleman whose voluntary aid proved of much service. From the concurrence of these independent observations we seem to be justified in assuming the probable existence of an envelope surrounding the photosphere, and beneath the chromosphere, usually so called, whose thickness must be limited to two or three seconds of arc, and which gives a discontinuous spectrum consisting of all, or nearly all, the Fraunhofer lines showing them, that is, bright on a dark ground."

Professor Young adds :—

"Seeche's continuous spectrum at the sun's limb is probably the same thing modified by atmospheric glare; anywhere but in the clear sky of Italy so much modified, indeed, as to be wholly masked."

The following was communicated to the *Athenæum*, Jan. 20, 1872:—

"Public Bungalow, Canonore, Dec. 28, 1871.

"Nothing, I am sure, could have been better laid than our plans, although, unfortunately, we were detailed to that 'west coast' which Mr. Lockyer was warned to avoid. Still, he was right in covering every available point, and we are rejoiced to hear that his party has had a complete success, while ours was as thorough a failure; since a dense mist totally obscured the sun from our view, except for a few moments before totality, when a rift for a moment opened, and showed the sun about one-half covered; but before the telescopes could be brought to bear the clouds closed sullenly and completely, and remained for three hours after the eclipse was over! Can you imagine the disappointment of men whose hearts were set upon one object, and who had travelled day and night for hundreds upon hundreds of miles to attain it? The failure of the eclipse party in Spain was nothing to it; we had this to look forward to. But now! Well, we must console ourselves with the hope that others have fared better. The only observations taken were some magnetic ones, by the Rev. Mr. Abbay. I fear most of the other Indian parties fared as we did.

"I need hardly say that we had everything in perfect order, and that we should have obtained some very valuable observations had the eclipse been visible. But it has been decreed otherwise.

"The swift darkness was very solemn, and you may believe that all the natives left work and hurried into our observatory for either through the Englishmen on the coffee plantations, or as they say from their own astronomers, they knew that the eclipse was coming. Round about in the plantations the coolies beat tom-toms and made a terrible row, for the serpent Rahoo is about to devour the sun, the great god they worship; and, although Rahoo lies coiled round the world to keep it together, which on the whole he does very fairly, yet guns and tom-toms shall, if possible, keep him from swallowing the sun. Wild cries, shouts, yells of grief, arose round the hill whereon our observatory stood, and a body of native police, under Head-Constable Morley, a half-breed, kept the coolies from further demonstrations. Some premature and unfortunate births, which have lately taken place at Manantoddy—and such affairs, I hear, often do accompany eclipses—are attributed to the attempt upon the life of the sun-god by this big serpent, Rahoo.

"So much for our own party. We can chronicle little but disappointment; but I am rejoiced to find, by advices that have since come to hand, that Mr Lockyer's party had all the good fortune which their chief deserved. He had taken every precaution not to be baffled; his party was so spread about and divided that it would have been strange indeed had he been unsuccessful. At his head-quarters at Bekul everything was prepared; and

although during the previous evening high banks of cloud had rendered many hearts uneasy, still, at half-past four on the eventful day, these had drifted seaward, and the immediate future was full of bright promise. On the old fort, turned into an observatory, two large telescopes were pointed to the sun. One was occupied by Mr. Lockyer, a large 9½-inch reflector; the other was under the guidance of Capt. Maclear and Mr. Pringle. Mr. M'Ivor assisted Mr. Lockyer at the spectroscope; Capt. Christie noted down Maclear's observations; and General Selby, Col. Farewell, and others, had telescopes ready to sketch the corona. At a few minutes after sunrise the first contact took place; all were ready, and a strict silence reigned in the fort, broken only by noting the phenomena visible or ascertainable by telescope, spectroscope, and polariscope. Bright lines in abundance are noted by Maclear, Mr. Lockyer observes them, and then, just when they have two minutes more to work, just 120 seconds, they see in a leaden-coloured, but otherwise clear sky, hung the eclipsed sun. It must have been a wonderful sight in the half-light—that brightness dimmed, but not all obscured—the sun, like the Miltonic Satan, appearing no less than 'Archangel ruined,' and above and below, but not on the sides, shooting glorious diamond rays, symmetrical pencils of light. I hear that this party has done 'noble work;' I hope that all others have been equally successful, and that the results of this expedition, of which this is my last record, will redound to the advantage of science, which, in good earnest, is the cause of Truth itself. F. T. R."

The following letter, communicated to the *Times*, will be read with much interest:—

"The curious breaking up of the thin annular rim of the sun, which is uncovered just before and just after totality, or which surrounds the moon during an annular eclipse, has been but occasionally observed, and some scepticism as to the accuracy of Baily's observations has lately arisen. Having attempted an explanation of the 'beads,' I have looked with much interest for the reports of the eclipse of 1870, for, if I am right, they ought to have been well seen on this occasion. This has been the case. We are informed that both Lord Lindsay and the Rev. S. J. Parry have observed them, and that Lord Lyndsay has set aside all doubts respecting their reality by securing a photographic record of their appearance.

"My explanation is that they are simply sun spots seen in profile—spots just caught in the fact of turning the sun's edge. All observers are now agreed as to the soundness of Galileo's original description of the spots—that they are huge cavities, great rifts of the luminous surface of the sun, many thousands of miles in diameter, and probably some thousand miles deep. Let us suppose the case of a spot—say, 2,000 miles deep, and 10,000 miles across (Sir W. Herschel has measured spots of 50,000 miles

diameter). When such a spot in the course of the sun's rotation reaches that part which forms the visible edge of the sun, it must, if rendered visible, be seen as a notch; but what will be the depth of such a notch? Only about 1-430th of the sun's diameter. But the apparent depth would be much less, as the edge or rim of the spot next to the observer would cut off more or less of its actually visible depth, this amount depending upon the lateral or east and west diameter of the spot and its position at the time of observation.

"Thus, the visible depth of such a notch would rarely exceed one-thousandth of the sun's apparent diameter, or might be much less. The sun being globular, the edge which is visible to us is but our horizon of his fiery ocean, which we see athwart the intervening surface as it gradually bends away from our view So small an indent upon this edge would, under ordinary circumstances of observation, be rendered quite invisible by the irradiation of this vast globular surface of the glaring photosphere, upon which it would visually encroach. If, however, this body of glare could be screened off, and only a line of the sun's edge, less than one-thousandth of his diameter, remain visible, the notch would appear as a distinct break in this curved line of light. If a group of spots, or a great irregular spot with several umbræ, were at such a time situated upon the sun's edge, the appearance of a series of such notches or breaks leaving intermediate detachments of the visible ring of the photosphere would be the necessary result, and thus would be presented exactly the appearance described as 'Baily's beads.'

"I have been led to anticipate a display of these beads during the late eclipse by the fact that some days preceding it a fine group of spots—visible to the naked eye through a London fog—had been travelling towards the eastern edge of the sun, and should have reached the limb at about the time of the eclipse. The beads were observed by the Rev. S. J. Perry just where I expected them to appear. I have not yet learnt on which side of the sun they were observed and photographed by Lord Lindsay.

"Baily's first observation of the beads was made during the annular eclipse of May 15, 1836. That year, like 1870, was remarkable for a great display of sun spots. As in 1870, they were then visible to the naked eye. I well remember my own boyish excitement when, a few weeks before the eclipse of 1836, I discovered a spot upon the reddened face of the setting sun—a thing I had read about and supposed that only great astronomers were privileged to see. The richness of this sun-spot period is strongly impressed on my memory by the fact that I continued painfully watching the dazzling sun, literally 'watching and weeping,' up to the Sunday of the eclipse, on which day also I saw a large spot through my bit of smoked glass.

"The previous records of these appearances of fracture of the thin line of light are those of Halley, in his memoir on the total

eclipse of 1715, and Maclauren's on that of 1737. Both of these correspond to great spot periods; the intervals between 1715, 1737, 1836, and 1870 are all divisible by 11. The observed period of sun-spot occurrence is eleven years and a small fraction.

"I am anxiously awaiting the arrival of Lord Lindsay's long exposure photographs of the corona, for if they represent the varying degrees of splendour of this solar appendage, the explanations offered in chapter 12 of my essay on 'The Fuel of the Sun' will be very severely tested by them.

"Yours respectfully,

"W. MATTIEU WILLIAMS.

"Woodside Green, Croydon, Jan. 4, 1872."

METEOROLOGY OF ENGLAND DURING THE YEAR 1871.

BY JAMES GLAISHER, ESQ., F.R.S.

THE exceedingly cold weather at the end of the last year continued till the 5th day of January, then somewhat moderated, but continued cold to the 13th; a few days of temperature a little above the average of the season followed. On the 19th the cold weather returned and continued to February 2nd; taking the temperature for the 33 days ending this day the average deficiency of daily temperature was $3\frac{3}{4}°$. From the 3rd of February to the 14th of March the weather was mostly mild and occasionally spring-like; the average excess of these 40 days was $4\frac{3}{4}°$ daily; from March 14th to the end of the quarter the weather was very changeable, the temperature being for two and three days together considerably in excess, and then for two or three days much in defect of its average. Upon the last 17 days the temperature was in excess averaging $1\frac{1}{2}°$ daily.

The frost and snow in January stopped all out-door farm work; the mild weather in February melted the snow, and being accompanied by rain caused rivers and streams to overflow, and in some cases to destroy a portion of the crops. Field work was all but stopped till towards the end of the month; vegetation was very backward, pastures and grass lands were bare, and the scarcity of fodder was severely felt. Towards the end of February, under the influence of the higher temperature, shrubs, hedges, and the early fruit-trees began to bud, and early spring flowers to bloom. All kinds of vegetables were scarce.

During the month of March agricultural operations progressed vigorously; the land was found to be unusually free from insects, and at the end of the quarter a very large breadth of land was under cultivation, but vegetation was still backward, having been checked by the frequent bleak north and east winds. The corn was spoken of as healthy, but forage and vegetables were very scarce.

With the exception of the period comprised between April 12th and 29th, the weather has been cold throughout the quarter, the temperature having been almost continuously below the average,

and on some days to large amounts. The average daily excess of temperature during the exceptional period above mentioned was 4°, and the average daily deficiency for the remaining 73 days exceeded $2\frac{1}{2}$°. The direction of the wind from April 12th to 29th was generally S.W., and during the rest of the quarter was generally E. or N., or a compound of these directions. The low temperature was the most severe both at the beginning and at the end of June, and the deficiency of temperature for this month from the average of the preceding thirty years exceeded 4° daily. The month of June 1860 was of the same low temperature, but previous to that we must go back as far as the year 1821 for one of lower temperature

The deficiency for the whole quarter amounted to more than $1\frac{1}{4}$° daily, from the average of 50 years, and there has been no corresponding quarter of as low a temperature at Greenwich since 1860, when April was much colder, but May was a little warmer, and, as above stated, June was about the same value, so that the mean temperature of the same three months in 1860 was nearly 1° lower than in 1871. Taking the whole country, the mean temperature for these three months is 50°·8, being very nearly of the same value as for the same three months in the year 1869, which was 50° 7.

The unseasonably cold weather which has for the most part prevailed throughout the quarter, together with the north winds, the cloudy sky and scanty sunshine, have caused vegetation generally to be very backward. At the end of the quarter cornfields still looked green. The harvest in the southern counties was not expected to begin for five or six weeks, and in the more northern counties the crops were not expected to ripen till towards the end of August. Hay-making had been frequently interrupted by rain. and much hay had been spoiled.

The cold weather which had been generally prevalent throughout the preceding quarter continued, with the slight exception of the few days, July 14th to 21st, till August 5th. This was followed by a period of 42 days of warm and genial weather, extending from August 6th to September 16th, during which interval the mean excess of temperature above the average was $4\frac{1}{2}$° daily From this time to the end of the quarter the weather was again cold, and heavy rain fell everywhere; the average deficiency of temperature was $3\frac{1}{4}$° daily.

In the middle of August all crops were backward, but the fine and forcing weather which followed brought them rapidly to maturity, almost simultaneously, but the gathering in of the harvest was much delayed by the scarcity of labour. By the end of August a large portion of the crops had been stacked. At the end of the quarter the rain was very beneficial to the south of England, but interfered with the completion of the harvest in Scotland, and also in some backward Irish districts. There were considerable complaints about the spread of the potato disease at different times during the quarter, by the completely rotting away

of the tuber, so that the stems were left without tubers attached. Generally the wheat crop was considered deficient.

For the whole country the temperature for the quarter was lower, both in its high day, low night, and mean value, than in the corresponding quarter in the three preceding years, whilst the amount of water mixed with air was the same as that in the years 1869 and 1870, and therefore the humidity of the air has been greater in 1871 than in either of the two preceding years. The fall of rain was nearly double of that in the same period in 1870, and exceeds both that in 1868 and 1869 by 2¼ inches and 2¾ inches respectively.

The mean readings of the barometer oscillated above and below the average several times during the first few days of January, but on the 13th a rapid fall commenced, and reached its minimum, 28°·73, at 9 h. A.M. of the 16th; a steady increase was recorded after this, and with but few interruptions continued till the end of the month; the range of reading for the month was 1·36 in. During February the mean daily readings were principally above the average, the minimum for the month, 29·06 in., occurring on the 10th. The range of reading amounted to 1·20 in.

The principal movements of the barometric column during March were as follows:—A decrease from 30·35 in. on the 1st to 29·42 in. on the 6th, an increase to 30·00 in. on the 10th, a decrease to 29·12 in. on the 16th, an increase to 30·15 in. on the 18th, a decrease to 29·59 in. on the 24th, and an increase to 30 28 in. on the 28th.

The range of reading amounted to 1·24 in.

The pressure of the atmosphere increased from 29·59 in. on the 3rd of April to its maximum reading for the month, 30·050 in. on the 6th, and continued generally about 29·8 in. till the 13th. On the 14th it decreased and continued with slight exception to the 19th, when 29·008 in., the minimum for the month, took place. From the 20th there were increasing readings till the 25th, to a maximum of 29 90 in., and this was followed by readings decreasing to 29 34 in. on the 29th The range of readings in the month was 1 042 in.

Throughout the month of May the mean daily values were, with six exceptions, above the average, and the range of readings was from 30·214 in. on the 7th, to 29 636 in on the 25th, or 0·578 in. only.

In June the waves of oscillation were small, and during the month there were no large departures from the average. The readings varied from 30·097 in., the maximum, on the 26th, to 29 337 in. the minimum, on the 17th; the range was therefore 0·760 in.

The changes of atmospheric pressure were small in amount but frequent during July, the tendency, however, being towards higher values in the middle than at the beginning and end of the month. The maximum value, 30·06 in., occurred on the 6th, and the minimum, 29·24 in., on the 25th, thus giving a range of 0·82 in.

In August the oscillations were larger than in July, the prin-

cipal movements being an increase to 30·02 in. on the 10th, a decrease to 29·26 in. on the 18th, an increase to 29·80 in. on the 21st, a decrease to 29·56 in. on the 24th, an increase to 30·31 in. on the 28th, and a decrease to 29·82 in. on the 30th. The maximum value recorded was 30·31 in., and the minimum 29·26 in., the range being 1·05 in.

The mean daily values in September were generally below the average from the 1st to the 11th, and from the 20th to the end of the month; the means for the remaining days being in excess. During the last few days several large movements were recorded, and on the 27th the minimum for the month occurred, viz., 28·85 in. The highest reading was 30·12 in. on the 14th, and the range 1·27 in.

The mean temperature of January was 33°·2, being 3°·1 lower than the average of 100 years, and lower than in any year back to 1842, when 32°·9 was recorded.

The mean temperature of February was 42°·4, being 3°·9 higher than the average of 100 years, and higher than in 1870 by 6°·2, but lower than in 1869 by 2°·9.

The mean temperature of March was 44°·9, being 4°·0 higher than the average of 100 years, and higher than in the corresponding month in any year back to 1859, when 46°·1 was recorded.

The mean temperature of April was 47°·7, being 1°·7 higher than the average of 100 years, but lower than the corresponding value in any year back to 1861, when 44°·3 was recorded.

The mean temperature of May was 51°·9, being 0°·7 below the average of 100 years, lower than in 1870 by 1°·5, but higher than in 1869 by 1°·4.

The mean temperature of June was 54°·8, being 3°·4 lower than the average of 100 years. The only instances in the period 1771–1871, in which the corresponding values were the same as this or of lower value are as follows:—1771, 54°·0; 1789, 54°·8; 1792, 54°·4; 1795, 53°·7; 1797, 54°·8; 1805, 54°·5; 1812, 54°·0; 1814, 53°·4; 1816, 53°·1; 1821, 54°·1; 1860, 54°·8.

The mean temperature of July was 61°·7, being 0°·1 higher than the average of 100 years, but lower than the corresponding values in 1870, 1869, and 1868.

The mean temperature of August was 64°·8, being 4°·0 higher than the average of 100 years, and in the period 1771–1870, the only instances in which the corresponding values have been the same as, or in excess of, this value are:—1780, 65°·7; 1802, 64°·8; 1842, 65°·4; and 1857, 65°·8.

The mean temperature of September was 57°·4, being 0°·9 higher than the average of 100 years, and higher than in 1870 by 1°·7.

The mean temperature of October was 49°·4.

The mean temperature of November was 37°·6, being 4°$\frac{3}{4}$ less than the average of 100 years, and the coldest November for 98 years.

The mean temperature of December was 38°·3.

The mean high day temperatures of January were 5°·8 lower, and of February and March 2°·9 and 5°·4 higher, than their respective averages.

The mean low night temperatures of January were 4°·2 lower than their averages; and of February and March 3°·5 and 1°·6 higher respectively.

Therefore the month of January was cold, and those of February and March warm both by day and night.

The mean high day temperature of April was the same as its average, and of May and June lower than their respective averages.

The mean low night temperature of April was higher than its average; and of May and June lower than their respective averages.

Therefore the nights in the month of April were warm, and in May and June both the days and nights were cold.

The mean high day temperatures of July and September were lower, and of August higher, than their respective averages.

The mean low night temperatures of July, August, and September were higher than their respective averages.

Therefore the days in July and September were cold, and in August warm, while the nights were warm during the whole three months.

The daily ranges of temperature were less than their respective averages in January and February by 1°·6 and 0°·7 respectively, and greater in March by 3°·7.

The daily ranges of temperature were less than their respective averages in April and June by 2°·0 and 2°·8, but greater in May by 1°·8.

The daily ranges of temperature were less than their respective averages in July and September by 2°·5 and 1°·2 respectively, but greater in August by 4°·7.

The fall of rain was 0·2 in in excess in January and 0·5 in. in defect in both February and March.

The fall of rain was 1·3 in. and 1·1 in. in excess in April and June respectively, and 1·3 in. in defect in May.

The fall of rain was 0·7 in. and 1·5 in. respectively, in defect in July and August, and 1·7 in in excess in September.

The mean temperature of the air in the three months ending February, constituting the three winter months, was 36°·4, being 1°·6 lower than the average of 100 years.

The mean temperature of the air in the three months ending May, constituting the three spring months, was 48°·2, being 1°·7 higher than the average of 100 years.

The mean temperature of the air in the three months ending August, constituting the three summer months, was 60°·4, being 0°·2 higher than the average of 100 years.

Horse Chesnut, first appearance of leaf buds on the, at Helston on February 18; and at Halifax on the 23rd. At Strathfield Turgiss, on March 1; at Llandudno on the 7th; and at Guern-

sey on the 11th. In leaf at Strathfield Turgiss on March 14; at Guernsey on the 26th; at Eastbourne on the 28th; and at Chislehurst on the 30th.

Hawthorn, first appearance of leaf buds on the, at Chislehurst on February 14; at Halifax on the 20th; and at Weybridge on the 21st. At Guernsey on March 1; at Llandudno on the 7th; and at Hull on the 18th. In leaf at Helston on March 11; at Halifax on the 20th; at Guernsey on the 26th; at Llandudno on the 27th; and at Eastbourne on the 31st.

Sycamore, first appearance of leaf buds on the, at Weybridge on February 2; at Chislehurst on the 14th, and at Halifax on the 23rd. At Strathfield Turgiss on March 6; and at Guernsey on the 26th. In leaf, at Halifax on March 26; at Eastbourne on the 27th; and at Chislehurst on the 30th.

Snowdrop in blossom on January 18 at Helston; on February 8 at Lampeter; on the 10th at Marlborough College; and on the 25th at Culloden.

Peach in blossom on March 4 at Helston; on the 9th at Oxford; on the 17th at West Harptre; on the 22nd at Wisbech; and on the 26th at Chislehurst.

Plum in blossom on March 20 at Strathfield Turgiss; on the 22nd at West Harptre, on the 24th at Helston; on the 25th at Oxford and Silloth; on the 26th at Chislehurst; and on the 30th at Weybridge Heath.

Pear in blossom on March 12 at Helston; on the 25th at Oxford and Llandudno; and on the 30th at West Harptre.

Cherry in blossom on March 20 at Helston; on the 23rd at Llandudno; on the 25th at Oxford; on the 26th at Chislehurst; and on the 28th at Weybridge Heath.

Field Elm in leaf on April 6 at Oxford; on the 13th at Weybridge; on the 23rd at Halifax; on the 27th at Helston and Osborne; and on the 30th at Miltown. On May 19 at Hull.

Wych Elm in leaf on April 10 at Guernsey; on the 23rd at Strathfield Turgiss, and on the 27th at Somerleyton. On May 5 at Wisbech; and on the 24th at Hull.

Oak in leaf on April 10 at Guernsey, on the 16th at Weybridge Heath; on the 20th at Strathfield Turgiss; on the 27th at Llandudno; and on the 29th at Chislehurst. On May 10 at Miltown; and on June 6 at Hull.

Lime in leaf on the 4th of April at Oxford and Wisbech; on the 10th at Guernsey; on the 14th at Weybridge Heath, on the 15th at Llandudno; on the 19th at Chislehurst, on the 25th at Strathfield Turgiss; and on the 26th at Helston. On May 6 at Miltown; and on the 16th at Hull.

Sycamore in leaf on March 27 at Eastbourne. On April 7 at Strathfield Turgiss, on the 9th at Weybridge Heath; on the 10th at Guernsey; on the 15th at Llandudno; on the 17th at Hull; on the 21st at Wisbech; on the 23rd at Helston; and on the 28th at Miltown.

Horse Chestnut in leaf on March 28 at Eastbourne. On April 4

at Weybridge Heath and Oxford; on the 9th at Wisbech; on the 12th at Llandudno; on the 16th at Halifax; and on the 21st at Miltown. On May 14 at Hull.

Common Poplar in leaf on April 10 at Strathfield Turgiss; on the 12th at Wisbech; on the 21st at Weybridge Heath and Chislehurst; and on the 24th at Halifax. On June 4 at Hull.

Hawthorn in leaf on March 31 at Eastbourne. On April 7 at Weybridge and Miltown; on the 10th at Hull; and on the 16th at Helston. On May 19 at Silloth.

Hazel in leaf on April 9 at Miltown; and on the 18th at Weybridge. On May 24 at Hull.

Walnut in leaf on April 20 at Wisbech. On May 2 at Weybridge. And on June 16 at Hull.

Apple in blossom on April 8 at Helston; on the 13th at Oxford; on the 15th at Weybridge; on the 18th at Wisbech; on the 19th at Strathfield Turgiss and Llandudno; and on the 20th at Miltown. On May 8 at Stonyhurst; and on the 10th at North Shields.

Pear in blossom on April 7 at Culloden; on the 10th at Miltown; on the 13th at Weybridge; on the 15th at Bywell; on the 16th at Wisbech; on the 20th at Stonyhurst; and on the 27th at Hull.

Cherry in blossom on April 1 at Strathfield Turgiss; on the 4th at Silloth; on the 7th at Miltown; on the 8th at Culloden; on the 10th at Bywell: on the 11th at Wisbech; and on the 17th at Hull. On May 13 at North Shields. Ripe on June 20 at Miltown; on the 27th at Stonyhurst; and on the 30th at Silloth.

Peach in blossom on March 24 at Miltown; and on the 28th at Strathfield Turgiss. On April 3 at Weybridge; and on the 30th at Halifax.

Plum in blossom on April 1 at Weybridge, Miltown, and Culloden; on the 16th at Stonyhurst; and on the 30th at Halifax.

Lilac in blossom on April 10 at Guernsey and Helston; on the 19th at Llandudno; on the 27th at Oxford; on the 28th at Strathfield Turgiss; and on the 29th at Wisbech. On May 1 at Weybridge: on the 2nd at Lampeter; on the 6th at Hawarden and Silloth; on the 7th at Miltown; on the 15th at Stonyhurst; and on the 27th at North Shields. On June 12 at Hull.

Laburnum in blossom on April 17 at Helston; on the 28th at Llandudno; on the 29th at Strathfield Turgiss; and on the 30th at Guernsey. On May 3 at Weybridge and Oxford; on the 5th at Lampeter; on the 8th at Chislehurst and Hawarden; on the 12th at Wisbech; on the 13th at Silloth; on the 16th at Stonyhurst; on the 20th at Miltown; and on the 26th at Hull.

Yellow Broom in blossom on April 17 at Weybridge Heath; and on the 30th at Miltown. On May 8 at Hull.

White Broom in blossom on April 21 at Llandudno. On May 5 at Miltown; on the 8th at Chislehurst; and on the 15th at Hull.

Mountain Ash in blossom on May 2 at Weybridge; on the 5th at Chislehurst; on the 10th at Llandudno; on the 18th at North Shields and Miltown; and on the 21st at Hull.

Honeysuckle in blossom on May 2 at Strathfield Turgiss; on the 4th at Llandudno; and on the 8th at Chislehurst. On June 5 at Hull; and on the 15th at Miltown.

Syringa in blossom on May 16 at Strathfield Turgiss; on the 25th at Chislehurst and Oxford; and on the 29th at Lampeter. On June 12 at Miltown; and on the 14th at Weybridge Heath.

Acacia in blossom on June 17 at Chislehurst; and on the 21st at Miltown.

Privet in blossom on June 17 at Chislehurst; on the 21st at Strathfield Turgiss; on the 26th at Weybridge Heath; and on the 27th at Miltown.

Wheat in ear on June 1 at Wisbech; on the 13th at Helston; on the 15th at Cardington; on the 18th at Silloth; on the 20th at Weybridge, on the 26th at Boston; and on the 29th at Hawarden. In flower on June 9 at Taunton; on the 21st at Helston; on the 24th at Weybridge and Chislehurst; on the 26th at Cardington; on the 27th at Silloth; and on the 28th at Hull.

Barley in ear on June 15 at Cardington; on the 21st at Weybridge; and on the 24th at Helston. In flower on June 26 at Cardington; and on the 30th at Weybridge and Hawarden.

Rye in ear on June 14 at Weybridge. In flower on June 18 at Weybridge; and on the 20th at Chislehurst. And on July 1 at Hull.

Oats in ear on June 17 at Weybridge Heath and Helston; and in flower on the 23rd at Weybridge Heath.

The swallow arrived at Taunton on March 15, and at Helston on the 21st.

The thrush arrived at Culloden on February 15, and at Guernsey on March 28.

The brimstone butterfly was seen at Bournemouth on February 10.

Cuckoo arrived on April 7 at Barnstaple; on the 10th at Guernsey; on the 12th at Llandudno, on the 13th at Truro and Strathfield Turgiss; on the 15th at West Harptre; on the 17th at Bournemouth and Weybridge; on the 18th at Hawarden; on the 19th at Holkham; on the 21st at Oxford; on the 22nd at Chislehurst, Greenwich, and Wisbech; on the 24th at Wilton and Cardington; on the 25th at Miltown; on the 26th at Halifax and Silloth; and on the 27th at Somerleyton, Hull, and Culloden. On May 1 at Lampeter and Stonyhurst; on the 2nd at Boston and Bywell; on the 6th at Allenheads; and on the 20th at North Shields.

Swallow arrived on April 6 at Osborne; on the 8th at Cardington, Holkham, and Miltown; on the 9th at Wilton and Chislehurst; on the 10th at Truro and Streatley; on the 12th at Hawarden; on the 13th at Helston, West Harptre, Weybridge, and Stonyhurst; on the 14th at Strathfield; on the 16th

at Llandudno, Hull, and Silloth; on the 18th at Wisbech; on the 19th at Somerleyton; on the 21st at Carlisle; on the 22nd at Bywell; on the 25th at Royston and Halifax; on the 26th at Lampeter; and on the 28th at Allenheads.

Nightingale arrived on April 7 at Holkham; on the 12th at Strathfield Turgiss; on the 13th at Royston; on the 16th at Streatley and Cardington; on the 17th at Weybridge; on the 19th at Chislehurst; and on the 23rd at Somerleyton. Departed on June 2 from Weybridge.

SATURN'S RINGS.

LIEUTENANT DAVIES has published a work in which he maintains the doctrine of the satellitic nature of Saturn's rings. According to this theory, the rings are composed of numbers of small satellites revolving round the planet, which satellites are, in fact, meteors arrested by the planet as they descended towards the sun. Mr. Davies concludes that the energy of the sun's light and heat has been derived frem meteors falling into it; a theory first brought into notice by Mayer, but in reality propounded long before his time. Mr. Proctor has lately propounded a different theory, that the solar corona consists of meteors ejected from the sun; but it is difficult to understand how the ejecting force can be perpetuated. The probability appears to us that the solar light and heat are maintained by meteors falling into the sun, as Mayer supposed; and that these meteors are generated in the realms of space by the action of light upon the imponderable ether producing such motions in it as generate gravity and lead to aggregation. On this theory the force evolved by the sun, and passing away as light and heat, is returned in the shape of a shower of meteors which exactly reproduces the energy expended. There is thus only a circulation and no loss, the supposition of which is impossible.—*Illustrated London News.*

THE PLANET VENUS.

Mr. W. E. DENNING, the hon. secretary of the Observing Astronomical Society, Bristol, has addressed to the *Times* the following letter:—

It will be in the recollection of many of your scientific readers that in March last the Observing Astronomical Society undertook to organise a systematic series of observations of the planet Venus, with the view of gaining a better knowledge as to the dusky markings which have been occasionally seen to diversify her disc. The Society, therefore, invited the co-operation of other astronomers, and the result was that many gentlemen possessing powerful astronomical instruments promised their assistance, and the observations commenced under favourable circumstances. They have, fortunately, also been carried on with success. Many of the observers have succeeded in detecting the

exceedingly faint markings on the planet's surface, which have been delineated and their general appearance recorded. Altogether 50 sketches of these markings have been made and forwarded to me; but until the whole of the results obtained can be collected, and a careful comparison instituted, it will be impossible to tell, with any degree of certainty, their degree of permanency, form, and general character. It may, however, be interesting to remark that some of the sketches, taken by different observers on the same date, show markings of the same form, although in some cases the details are evidently different. That this discordance should exist is not surprising when we consider that it is a matter of great difficulty to make out the precise forms of these appearances. Indeed, some of the observers have entirely failed to detect them, although the planet has on many occasions been subjected to a very careful scrutiny.

One of the most successful of the observers is Mr. George M. Seabrook, of the Temple Observatory, Rugby, who, with the 8¼ in. equatorially-mounted refractor which was formerly in the possession of the late Rev. W. R. Dawes, F.R S., has frequently seen and delineated the markings on the planet's disc. They, however, appear to be extremely faint, cloud-like objects, and must necessarily be looked for with none but the most excellent defining telescopes; and it is owing to this fact, perhaps, that so few observers have, until quite recently, been able to detect them. Now, however, that more interest is attached to the observation of this planet, through the exertions of the members of the Observing Astronomical Society, it is exceedingly probable that the markings on her surface will be much more frequently lookèd for, and more often observed, than was formerly the case.

It is proposed to continue the observations until October, 1872, and it is also intended to collect all previous drawings and records of the planet's appearance. To effectually accomplish this the Society will necessarily require the assistance of amateur observers and others who may have in their possession any sketches or results of observations of the markings. It will also be very necessary to consult the works of earlier observers, so that a mass of data may be collected and placed before a thoroughly experienced astronomer, who will carefully investigate it and decide as to the nature and character of the dark streaks and markings of the planet, which have been considered, for very many years, beyond the reach of any but the most powerful and perfect telescopes. The irregularities which are distinguishable in the outline of the terminator (the boundary between the dark and illuminated portion of the disc) will also receive due attention.

THE ROYAL METEOROLOGICAL OBSERVATORY AT KEW.

(*From the Inaugural Address of President Sir William Thomson to the British Association.*)

One of the most valuable services to science which the British

Association has performed has been the establishment, and the twenty-nine years' maintenance, of its Observatory. The Royal Meteorological Observatory of Kew was built originally for a sovereign of England who was a zealous amateur of astronomy. George the Third used continually to repair to it when any celestial phenomenon of peculiar interest was to be seen; and a manuscript book still exists filled with observations written into it by his own hand. After the building had been many years unused, it was granted, in the year 1842, by the Commissioners of Her Majesty's Woods and Forests, on application of Sir Edward Sabine, for the purpose of continuing observations (from which he had already deduced important results) regarding the vibration of a pendulum in various gases, and for the purpose of promoting pendulum observations in all parts of the world. The Government granted only the building—no funds for carrying on the work to be done in it. The Royal Society was unable to undertake the maintenance of such an observatory; but, happily for science, the zeal of individual Fellows of the Royal Society and Members of the British Association gave the initial impulse, supplied the necessary initial funds, and recommended their new institution successfully to the fostering care of the British Association. The work of the Kew Observatory has, from the commencement, been conducted under the direction of a Committee of the British Association; and annual grants from the funds of the Association have been made towards defraying its expenses up to the present time. To the initial object of pendulum research was added continuous observation of the phenomena of meteorology and terrestrial magnetism, and the construction and verification of thermometers, barometers, and magnetometers designed for accurate measurement. The magnificent services which it has rendered to science are so well known that any statement of them which I could attempt on the present occasion would be superfluous. Their value is due in a great measure to the indefatigable zeal and the great ability of two Scotchmen, both from Edinburgh, who successively held the office of Superintendent of the Observatory of the British Association—Mr. Welsh for nine years, until his death in 1859, and Dr. Balfour Stewart from then until the present time. Fruits of their labours are to be found all through our volumes of Reports for these twenty-one years.

The institution now enters on a new stage of its existence. The noble liberality of a private benefactor, one who has laboured for its welfare with self-sacrificing devotion unintermittingly from within a few years of its creation, has given it a permanent independence, under the general management of a Committee of the Royal Society. Mr. Gassiot's gift of 10,000 . secures the continuance at Kew of the regular operation of the self-recording instruments for observing the phenomena of terrestrial magnetism and meteorology, without the necessity for further support from the British Association.

The success of the Kew Magnetic and Meteorological Observatory affords an example of the great gain to be earned for science by the foundation of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be, not teaching, but experimenting. Whether we look to the honour of England, as a nation which ought always to be the foremost in promoting physical science, or to those vast economical advantages which must accrue from such establishments, we cannot but feel that experimental research ought to be made with us an object of national concern, and not left, as hitherto, exclusively to the private enterprise of self-sacrificing amateurs, and the necessarily inconsecutive action of our present Governmental Departments, and of casual Committees. The Council of the Royal Society of Edinburgh has moved for this object in a memorial presented by them to the Royal Commission on Scientific Education and the Advancement of Science. The continent of Europe is referred to for an example to be followed with advantage in this country.

THE NEXT TOTAL SOLAR ECLIPSE.

MR. J. R. HIND (Mr. Bishop's Observatory, Twickenham) has addressed to the *Times* the following letter:—"On the occasion of the eclipse of the sun in December last there were frequent inquiries as to the date of the next Solar Eclipse which will be total in England. I am not aware that any one was in a position at that time to reply to these queries. It was known from the calculations of Hallaschka and others that during the present century there could be no such eclipse, but with the exception of one or two dates in the ensuing century which had been vaguely assigned, and which have proved to be erroneous, I believe no attempt has been made to ascertain this date, or, at least, that no results of the attempt have been published. The uncertainty thus attaching to the subject, though one of mere curiosity to the present generation, has induced me to undertake a systematic and careful examination of future eclipses with the immediate object of discovering the one in question, and I now forward to you the principal results. In this inquiry I have examined accurately many eclipses, in which the central line has not eventually been found to pass over this country, it being very difficult in certain cases to determine, without a rigorous computation, how the tracks would run. For the sake of brevity I shall here allude only to two or three such eclipses.

During the first half of the 20th century I have not found the phenomenon of which I was in search. The eclipses in which the central line approaches nearest to our shores are the following:—That of August 30, 1905, when entering Spain, near Corunna, and passing over Madrid, it launches into the Mediterranean at Valencia; that of August 21, 1914, when meeting the

coast of Norway, in latitude 64½ deg., and traversing Nykoping, south of Stockholm, it arrives on Prussian territory at Memel, whence its course is over the south-west of Russia; that of February 3, 1916, which will end at sea, 9½ deg. west of Greenwich, and latitude 49½ deg.; and that of 1925, January 24, passing off near the Faro Isles. On the 30th of June, 1954, indeed, there will occur an eclipse, wherein the zone of totality just touches the British Islands; it includes the northernmost of the Shetland group. At the northern extremity of the island of Unst I find the last ray of sunlight disappears at about 0h. 23m. P.M. local time, and the total eclipse continues 2m. 20s. This eclipse of June 30, 1954, is, consequently, the first in which totality can be witnessed in any part of the British islands, but to discover an eclipse that will be total in England I have found it necessary to continue the calculations to nearly the close of the same century. Such an eclipse (according to my investigation) will not occur till the 11th of August. 1999, when the circumference will be nearly as follows:—The central and total eclipse will enter upon the earth's surface in the southern part of the Gulf of Mexico; thence traversing the Atlantic, it meets the English coast in Padstow, in Cornwall, and crossing the south of Devon enters the Channel at Torquay (which will be the most favourable place for observation in this country), and passing over the Eddystone, reaches France about 15 miles east of Dieppe. It will be central and total, with the sun on the Mediterranean some 25 miles south-west of Pesth, and traversing Asia Minor, Persia (at Ispahan), &c., will finally leave the earth's surface in the Bay of Bengal. At Torquay the first contact of limbs, or commencement of the eclipse, occurs at 8.23 A.M., local mean time, and the last contact at 11.20 A.M. Totality begins at 10h. 0m. 43s., with the sun at an altitude of 48 degrees, and continues 2m. 4s. At Plymouth the duration of total eclipse is 1m. 58s., at Weymouth 1m. 55s. The southern part of the Isle of Wight falls within the northern limit of totality according to my calculation.

The last total solar eclipse visible in London occurred on the 3rd of May, 1715, and was successfully observed in the metropolis and at many other English stations. In drawing the attention of the Royal Society to this eclipse, Dr. Halley mentioned that since the 20th of March, 1140, he could not find any one that had passed over London, though in the meantime the moon's shadow had frequently crossed other parts of the country. The natural inference from this remark has been that the eclipse of 1140 was total in London, though Halley does not state whether he was guided by historical authority or by a calculation of the circumstances from the solar and lunar tables. The eclipse is recorded by William of Malmesbury:—'While persons were sitting at their meals the darkness became so great that they feared the antient chaos was about to return, and upon going out immediately they perceived several stars about the sun.' The Saxon

Chronicle refers to it in similar terms. I have calculated the particulars of this eclipse, introducing the last value of the secular acceleration of the moon's mean motion, so that my results should very closely represent the circumstances of the phenomenon as it actually occurred. I find the eclipse was not total in London. The central line entered our island at Aberystwith, and passing near Shrewsbury, Stafford, Derby, Nottingham, and Lincoln, reached the German Ocean ten miles south of Saltfleet. The northern limit of the total eclipse passed near Holyhead, Bradford, Leeds, and York, and left England between Filey and Flamborough Head. The southern limit met the coast of Glamorgan below Swansea, and passed over Monmouth, Northampton, Huntingdon, and Norwich; consequently, the nearest approach of the total phase to London was at a point on the borders of Northamptonshire and Bedfordshire. By a special calculation for a point near Stafford, about the centre of the path across England, I find the total eclipse began at 2.36 P.M., local mean time, and that the sun was hidden 3m. 26s., while at an altitude of more than 30 deg.

"The 'stars about the sun,' remarked by our forefathers, were probably the planets Mercury and Venus, then within a degree from each other, and 10 deg. west of the sun, and possibly the bright stars in the constellations Pegasus and Andromeda, forming what is frequently called 'the square of Pegasus.' Mars and Saturn were also at that time within a degree from each other, but very near the western horizon.

"It is, therefore, necessary to look further back than the year 1140 for the total solar eclipse in London next preceding that of 1715. I greatly doubt if, excepting the eclipse of August 11, 1999, described above, there can be any total solar eclipse visible in England for 250 years from the present time."

FUTURE SOLAR ECLIPSES.

MR. J. R. HIND (Mr. Bishop's Observatory, Twickenham) has addressed to the *Times* the following letter:—The important physical observations which have been made during recent total eclipses of the sun have invested these phenomena with an interest independent of that attaching to the striking appearance in nature witnessed on these occasions, which have so frequently formed the subject of wonder and admiration in past times. I am thereby induced to send you a brief notice of the total eclipses which will occur during the next twenty years, founded upon a series of calculations undertaken for my own information, and very recently completed. I shall avoid introducing numerical results to any extent, and trust to verbal description as affording a sufficient guide to the course of the moon's shadow over the surface of the earth in each eclipse. I shall endeavour, also, to indicate the localities in which observations may be made with the greatest advantages. One or two

eclipses, where the apparent diameters of sun and moon will be so nearly equal as to unfit them for favourable physical observation, will be omitted.

The eclipse of December 12 next is described generally in the various ephemerides. It will be total in Southern India and in Ceylon in the early morning. At Ootacamund, the sanatory station in the Neilgherry Hills, for 2m. 8s., totality commencing at 7h. 32m. 53s. A.M. local mean time, with the sun 18 deg. above the horizon. The first contact of limbs occurs here a quarter of an hour after sunrise, so that the whole eclipse is visible. At Trincomalee totality commences at 7h. 55m. 45s. A.M. local time, and continues 2m. 11s. In the northern part of the Australian continent the eclipse may extend over more than four minutes. Expeditions are organising for several stations along the central line. In the Neilgherries, in particular, it appears favourable weather is confidently expected. I remark upon other eclipses in order of date :—

1. The eclipse of April 16, 1874.—The central line commences in the Antarctic Regions near the position marked upon our charts as "Weddell's farthest," and crosses Southern Africa, from the Orange River district to Natal. The only locality in which observations could be advantageously made lies between the Orange River and Lion mountains, near the west coast, in about 29 deg. south latitude. Taking as a point for special calculation 18 deg. E., 29 deg. 11m. S., I find the last ray of sunlight disappears at 3h. 53m. 54s. P.M. local time, and totality continues 3m. 37s., the sun at an altitude of 22 deg.; this point is very near the central eclipse. On the eastern coast the sun's elevation is less than 10 deg.; at Port Natal he is obscured for 50s. only, but some 75 miles further north the total eclipse may extend to nearly 3m. At the Royal Observatory, Cape of Good Hope, there is a very large partial eclipse, the greatest phase at 3h. 50m. P.M.

2. The eclipse of April 6, 1875.—The greater part of the central line rests upon the Indian Ocean, from Madagascar in a north-easterly direction, but it will traverse further India (British Burmah) and Siam, and the totality may be very favourably observed in this region, the sun being high in the heavens. At Mergui he is obscured 4m. 6s., at Tenasserim 2m. 48s., and at Bangkok 3m. 19s At Mergui, which is near the centre of the shadow, the sun disappears at 1h. 59m. 40s. A.M., while at an altitude of 60 deg.

3. The eclipse of September 17, 1876.—The total phase commences a little below the equator, north of New Guinea, and passes over the Pacific to the south-west of Cape Horn; it appears to escape all the principal islands; in 175 deg. W. the duration is 1m. 40s., which is nearly the *maximum*. The phenomenon does not promise to be of utility to the physical astronomer.

4. The eclipse of July 29, 1878.—The belt of totality runs

from the mountains north of Nertchinsk, in Siberia, over Behring's Straits, British Columbia, the Western States of America (Colorado, Texas, &c.), and by Havannah to Port-au-Prince, Hayti, near which point it passes off the earth. In 135 deg. 30m. W., and 59 deg. 30m. N., where the sun will be near the meridian, the duration of total eclipse is 3m. 6s.; at Denver, Colorado, 2m. 47s.; at Havannah, 1m. 53s.; and at Port-au-Prince, 1m. 24s.; but here the sun is less than five degrees from the west horizon. This will be the fourth return of the great eclipse of 1806, which was also visible in the United States.

5. The eclipse of May 17, 1882.—The central line commences in the Ashantee territory, traverses Africa to Upper Egypt and the extremity of the Sinaite peninsula at the entrance of the Gulf of Akabah; the duration of totality here is rather less than two minutes. The after course is by Teheran and Kashgar across the Chinese Empire to Shanghai, where the eclipse is total for 20 seconds only, with the sun 18 degrees high.

6. The eclipse of May 6, 1883.—The central line commences in 156 deg. E., about 35 deg. S. of the equator, and passes below Norfolk Island, the Friendly Islands, and among the Marquesas, ending in about 87 deg. W., and 14 deg. S. Its course is, therefore, a very unfavourable one for observations, being a sea-track almost throughout. If any station is found, it may probably be between 150 deg. and 160 deg. west longitude. In the longitudes of the Marquesas, the sun may be observed 5m. 15s

7. The eclipse of September 9, 1885.—Begins at sea east of Tasmania, and is total in New Zealand in the southern part of the Northern Island. At Wellington totality continues only 40 seconds, the sun disappearing at 7h. 42m. 22s. A.M., at an altitude of 15 deg.; but some 35 miles further south, it may extend over nearly 2 minutes The south latitude of the central line afterwards increases until it passes off the earth within the Antarctic Circle. New Zealand will, consequently, be the only available station in this eclipse.

8. The eclipse of August 29, 1886.—As regards the length of duration of totality, this will be the most notable phenomenon within the period of which I am writing. The central line commences among the more southerly of the Bahamas Islands, and, traversing the Atlantic, meets the Coast of Africa, near Portendik, leaving this continent on the eastern side, south of the equator, and ending 2 degrees north of the upper extremity of Madagascar. Calculating for a point on the West Coast of Africa in latitude 17 deg. 55 m. S, which is about 10 miles south of Portendik, and close upon the central line, I find the total eclipse commences at 11h. 27m. 36s. A.M. local time, and continues 6m. 21s., the sun being at an altitude of 79 deg.

9. The eclipse of August 19, 1887.—Frequent reference has been made in astronomical works to this eclipse, on the assumption that the line of totality would reach England. This, however, is now known to be an error. The central line begins at

Bernberg in Anhalt, passes near Wilna and across Russia to Perm, thence by Tobolsk and rather north of Irkutsk to Manchooria, and over Japan in about 38 deg. N., to the Pacific, where it ends in 174 deg. E. and 24 deg. 30 m. N. The duration of totality at Wilna, one of the most westerly points at which the sun can be well seen, is 2m. 15s., but on the shores of Lake Baikal, where he is nearly on the meridian, it may extend to 3m. 40s.

10. The eclipse of December 22, 1889.—Commences in the Caribbean Sea, and, passing over Barbadoes into the Atlantic, arrives on the African coast in Angola, thence traversing Lake Tanganyika, it continues its course to the Indian Ocean, and leaves the earth in about 61 deg. E. and 7 deg. N. At Bridgetown, Barbadoes, totality begins at 6h. 47m. 6s. A.M., with the sun at an altitude of 6 deg., and continues 1m. 48s. On the Angola coast in 10 deg. south latitude, he is 56 degs. above the horizon, and is obscured 3m. 34s., the middle of the eclipse falling at 2h. 11m. P.M., local time.

This completes the list of total eclipses which will be available for physical observations during the next 20 years. In one or two cases, however, it will be seen that such observations may be attended with great difficulties.

VAST SUN SPOTS.

PROFESSOR DANIEL KIRKWOOD, in the *American Journal of Science*, writes that one of the largest and most remarkable Spots ever seen on the Sun's disc, appeared in June 1843, and continued visible to the naked eye for seven or eight days. The diameter of this spot was, according to Schwabe, 74,000 miles; so that its area was many times greater than that of the earth's surface. Now it has been observed, during a number of sun spot cycles, that the larger spots are generally found at or near the epoch of the greatest numbers. The year 1843 was, however, a minimum epoch of the eleven year cycle. It would seem, therefore, that the formation of this extraordinary spot was an anomaly, and that its origin ought not to be looked for in the general cause of the spots of Schwabe's cycle.

TEMPERATURE OF NOVEMBER.

THE month of November, 1871, was of lower temperature than any other November this century.

METEOROLOGY OF 1871.

Monthly Means of Results for Meteorological Elements at the Royal Observatory, Greenwich, in the year 1871.

1871 Months	Mean Reading of the Barometer	Temperature of the Air: Highest	Temperature of the Air: Lowest	Temperature of the Air: Range in the Month	Temperature of the Air: Mean of all the Highest	Temperature of the Air: Mean of all the Lowest	Temperature of the Air: Mean daily Range	Temperature of the Air: Mean Temperature	Mean Temperature of Dew Point	Mean Elastic Force of Vapour	Mean Weight of Vapour in a Cubic Foot of Air	Mean Additional Weight required to saturate a Cubic Foot of Air	Mean Degree of Humidity (Saturation=100)	Mean Weight of a Cubic Foot of Air	Mean Amount of Cloud 0–10	Number of Rainy Days	Rain: Amount collected on the ground: Gauge read daily	Rain: Amount collected on the ground: Gauge read monthly	Wind, from Osler's Anemometer, Number of Hours of Prevalence of each Wind referred to different Points of Azimuth: N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Number of Calm or nearly Calm Hours	Mean Daily Pressure in lbs. on square foot	From Robinson's Anemometer: Mean daily Horizontal Movement of air in Miles
	In	°	°	°	°	°	°	°		In	Grs	Grs		Grs			In.	In.											
Jan.	29·646	46·7	18·3	28·4	37·4	29·3	8·1	32·2	29·7	0·165	2·0	0·2	87	558	8·0	18	2·05	2·10	103	132	66	87	102	148	68	19	19	0·25	260
Feb.	29·847	57·0	25·0	32·0	48·3	37·5	10·8	42·4	38·1	0·230	2·7	0·5	86	551	7·8	14	1·09	1·10	28	23	58	54	84	284	162	36	3	0·47	319
March	29·876	70·9	28·9	42·0	55·0	36·7	18·3	44·9	38·7	0·235	2·7	0·7	79	549	5·7	10	1·10	1·07	84	72	74	73	84	243	58	32	24	0·36	282
April	29·648	66·5	29·1	37·4	57·8	41·2	16·6	47·7	42·5	0·272	3·1	0·7	83	541	7·1	18	3·03	2·96	38	51	121	59	27	228	137	59	0	0·35	285
May	29·907	79·5	34·0	45·5	64·4	42·1	22·3	51·9	43·7	0·285	3·3	1·1	74	541	5·6	7	0·68	0·70	79	225	114	50	36	72	105	63	0	0·22	234
June	29·761	77·2	38·7	38·5	66·3	47·9	18·4	54·8	48·4	0·340	3·9	1·0	78	535	8·1	18	2·95	2·95	246	90	51	62	57	132	48	25	9	0·20	246
July	29·690	82·6	46·8	35·8	72·6	54·0	18·6	61·7	53·9	0·416	4·6	1·5	76	526	6·8	17	3·25	3·15	32	21	16	13	97	452	89	24	0	0·30	292
Aug.	29·855	89·2	46·1	43·1	78·1	53·8	24·3	64·8	54·4	0·424	4·7	2·1	69	526	3·9	6	0·86	0·80	22	106	133	62	69	207	82	30	33	0·24	215
Sept.	29·719	82·0	39·0	43·0	67·5	50·3	17·2	57·4	49·9	0·360	4·0	1·3	76	532	6·8	15	4·12	3·96	42	247	98	63	58	113	52	28	19	0·16	238
Oct.	29·785	68·4	31·2	37·2	58·6	41·9	16·7	49·4	45·1	0·301	3·5	0·6	86	542	5·9	12	1·37	1·50	31	66	51	126	170	167	36	21	76	0·08	193
Nov.	29·816	51·0	20·3	30·7	43·2	32·7	10·5	37·6	33·4	0·191	2·2	0·5	85	556	5·9	10	0·57	0·62	74	127	125	86	41	68	132	46	21	0·26	189
Dec.	29·925	48·8	18·6	30·2	42·2	34·2	8·0	38·3	35·0	0·204	2·4	0·4	88	557	6·8	17	1·23	1·30	94	45	9	9	41	290	205	37	14	0·48	254
Means	29·790	68·3	31·3	37·0	57·6	41·8	15·8	48·7	42·7	0·285	3·3	0·9	81	543	6·5	162	22·30	22·21	873	1205	916	744	866	2404	1114	420	218	0·28	251
																Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum	Sum		

Explanation.—The cistern of the barometer is about 160 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of corrections from Mr. Glaisher's paper, in the *Philosophical Transactions*, Part I., 1848; and from the readings of the wet and dry bulb thermometers, thus corrected, the several hygrometrical deductions in columns 11 to 16 are calculated by means of Glaisher's *Hygrometrical Tables. Fifth Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of a column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in column 12 show the length of a column of mercury balanced by the water alone; and if the numbers in this column be subtracted from those in column 2, the result will be the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been, had no water been mixed with the air

INAUGURAL ADDRESS OF SIR WM. THOMSON, F.R.S., PRESIDENT OF THE BRITISH ASSOCIATION, 1871.

PROFESSOR HUXLEY, in resigning his seat, thanked the Association for the honour conferred upon him, and its officers for their cordial and valuable assistance. He then paid a warm tribute to the great merits of his successor, to whom he gave up his chair. Sir William Thomson, the new President, then entered upon the duties of his office, and proceeded to deliver the customary inaugural address.

Sir William Thomson referred, in the first place, to the connexion of the Association with Edinburgh through the honoured names of some of its founders, and quoted from a former address by Sir David Brewster a brief account of the "small band of pilgrims who carried the seeds of the Institution into the more genial soil of our sister land."

"Sir John Robison, Professor Johnston, and Professor J. D. Forbes were the earliest friends and promoters of the British Association. They went to York to assist in its establishment, and they found there the very men who were qualified to foster and organise it. Headed by Sir Roderick Murchison, one of the very earliest and most active advocates of the Association, there assembled at York about 200 of the friends of science."

A letter written by Brewster in February, 1831, to Professor Phillips at York, carries back the history to an earlier date, and contains inquiries as to the accommodation to be obtained in the city for a large meeting (probably of 100 persons!), and as to the willingness of the Mayor and other influential persons to promote the aims that were in view—namely, "to make the cultivators of science acquainted with each other, to stimulate them to new exertions, to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

Of the four pilgrims from Scotland to York not one now survives, and of the seven first Associates one more has gone over to the majority since the Association last week. Vernon Harcourt is no longer with us, but his influence remains. Brewster was the founder of the British Association; Vernon Harcourt was its lawgiver. His code is to this day the law of the Association.

On the 11th of May last Sir John Herschel died, in the 80th year of his age, leaving a name that is a household word throughout the civilized world, and discoveries which, in the hands of Stokes, Sylvester, and Gregory, have served as foundations for progress alike in physics and pure mathematics. Of his gigantic work in astronomical observation, I need say nothing. Doubtless, a careful account of it will be given in the *Proceedings of the Royal Society of London* for the next anniversary meeting.

In the past year, also, another representative man of British science is gone, in the person of Professor De Morgan. His great book on the *Differential Calculus* was, for the mathematical student of thirty years ago, a highly-prized repository of all the best things that could be brought together under that title. It is no less valuable now; and if less valued, may not this be because it is too good for examination purposes, and because the modern student, labouring to win marks in the struggle for existence, must not suffer himself to be beguiled from the stern path of duty by any attractive beauties in the object of his study?

One of the most valuable services to science which the British Association has rendered has been the establishment and maintenance of the Kew Observatory. Built originally for George III., and left for many years unused, it was granted by the Commissioners of Woods and Forests, in 1842, on the application of Sir Edward Sabine, for the purpose of carrying out and promoting observations upon the Pendulum. Individual Fellows of the Royal Society and members of the British Association supplied the initial funds. The institution now enters upon a new stage of existence, thanks to the noble liberality of a private benefactor. Mr. Gassiot's gift of 10,000*l.* secures its future operations, without the necessity of further support from the Association.

The success of the Kew Observatory, and the great value of the work done there, afford an example of the great gain to be earned for science by the foundation of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be, not teaching, but experimenting, and such observatories and laboratories, here as upon the Continent, should be provided and fostered by the State. The physical laboratories which have grown up in the Universities of Glasgow and Edinburgh, and in Owens College, Manchester, show the want felt of colleges of research; but they go but infinitesimally towards supplying it, being absolutely destitute of means, *matériel*, or *personnel* for advancing science, except at the expense of volunteers, or for securing that volunteers shall be found to continue even such little work as is at present carried on.

Besides abstracts of papers read, and discussions held before the sections, the annual volumes of the Association contain much valuable matter in the shape of reports on particular branches of science from men well qualified to prepare them. Some of these have led to vast practical results; others, of a more abstract character, are valuable as powerful and instructive condensations and expositions of the branches of science to which they relate. I cannot better illustrate the two kinds of efficiency realised in this department than by referring to Cayley's *Report on Abstract Dynamics* and Sabine's *Report on Terrestrial Magnetism*. I believe that it is due to the scientific character of the Admiralty *Compass Manual*, based upon the joint work of Sabine and Archibald Smith, that no iron ship of Her Majesty's

Navy has ever been lost by errors of the compass. The *Manual* is adopted as a guide by all the navies of the world. It has been translated into Russian, German, and Portuguese, and it is at present being translated into French.

In the reports of the early years of the British Association, we find also evidence of the diligent cultivation of the science of terrestrial magnetism, into which research is still being steadily pursued. Materials from scientific travellers of all nations, from our home magnetic observatories, from the magnetic observatories of St. Helena, the Cape, Van Diemen's Land, and Toronto, and from the scientific observatories of other countries, have been brought together by Sabine. Silently, day after day, night after night, for a quarter of a century he has toiled, with one constant assistant always by his side, to reduce these observations. At this moment, while we are here assembled, I believe that in their quiet summer retirement in Wales, Sir Edward and Lady Sabine are at work on the magnetic chart of the world. If two years of life and health are granted to them, science will be provided with a key which must powerfully conduce to the ultimate opening up of one of the most refractory enigmas of cosmical physics, the cause of terrestrial magnetism.

To give any sketch, however slight, of scientific investigation performed during the past year would, even if I were competent for the task, far exceed the limits within which I am confined; and I can only select some of those which have struck me as most notable. Great service has been done to science by the British Association in promoting accurate measurement in various subjects. To the non-scientific imagination this seems a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science, including Newton's discovery of the law of gravitation, have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results. The origin of exact science in terrestrial magnetism is traceable to Gauss's invention of methods of finding the magnetic intensity in absolute measure. Weber extended the practice of absolute measurement to electric currents, the resistance of an electric conductor, and the electromotive force of a galvanic element. He made the beautiful discovery that resistance and the reciprocal of resistance are each of them a velocity. He made an elaborate and difficult series of experiments to measure the velocity which is equal to the conducting power in electro-static measure, and at the same time to the resistance in electro-magnetic measure, in one and the same conductor. Maxwell discovered that this velocity is physically related to the velocity of light. The most accurate possible determination of Weber's critical velocity is just now a primary object of the Association's Committee on Electric Measurement, and it is at present premature to speculate as to the closeness of the agreement between that velocity and the velocity of light.

This leads me to remark how much science, even in its most lofty speculations, gains in return for benefits conferred by its application to promote the social and material welfare of man. Those who perilled and lost their money in the original Atlantic telegraph were impelled and supported by a sense of the grandeur of their enterprise, and of the world-wide benefits which must flow from its success; they were, at the same time, not unmoved by the beauty of the scientific problem directly presented to them, but they little thought that it was to be immediately through their work that the scientific world was to be instructed in a long neglected and discredited fundamental electric discovery of Faraday's, or that, again, when the assistance of the British Association was invoked to supply their electricians with methods for absolute measurement (which they found necessary to secure the best economical return for their expenditure, and to obviate and detect those faults in their electric material which had led to disaster), they were laying the foundation for accurate electric measurement in every scientific laboratory in the world, and initiating a train of investigation which now sends up branches into the loftiest regions of and subtlest æther of natural philosophy. Long may the British Association continue a bond of union and a medium for the interchange of good offices between science and the world!

The greatest achievement yet made in molecular theory of the properties of matter is the kinetic theory of gases, shadowed forth by Lucretius, definitely stated by Daniel Bernoulli, largely developed by Herapath, made a reality by Joule, and worked out to its present advanced state by Clausius and Maxwell, who has completed the dynamical explanation of all the known properties of gases, except their electric resistance and brittleness to electric force. The progress of spectroscopic research has led to important results with regard to the solar atmosphere and to the corona seen round the dark disc of the moon eclipsing the sun. It seems to have been proved that at least some sensible part of the light is a terrestrial atmospheric halo or dispersive reflection of the light of the glowing hydrogen and "belium" round the sun. I believe I may say on the present occasion, when preparation must again be made to utilize a total eclipse of the sun, that the British Association confidently trusts to our Government exercising the same wise liberality as heretofore in the interests of science.

The results of spectrum analysis have also given finally conclusive proof against Mayer's hypothesis, that the sun's heat is supplied dynamically from year to year by the influx of meteors.

Most important steps have recently been taken towards the discovery of the nature of comets, establishing with nothing short of certainty the truth of an hypothesis which had long appeared to me probable, that they consist of meteoric stones; accounting satisfactorily for the light of the nucleus, and giving a simple and rational explanation of phenomena presented by

the tails of comets, which had been regarded by the greatest astronomers as almost preternaturally marvellous. It is thoroughly proved, by the investigations of Professor Newton, of Yale College, followed and completed by those of Adams, that Temple's comet I., 1866, consists of an elliptic train of minute planets, of which a few thousands or millions fall to the earth annually about November 14, when we cross their track. We have probably not yet passed through the very densest part; but thirteen times we have passed through a belt greatly denser than the average. The densest part of the train, when near enough to us, is visible as the head of the comet, and, according to Tait's theory, is self-luminous by reason of collisions among its constituents; while the tail is merely a portion of the less dense part of the train, illuminated by sunlight, and visible or invisible to us according to circumstances not only of density, degree of illumination, and nearness, but also of tactic arrangement, as of a flock of birds, or the edge of a cloud of tobacco smoke.

The essence of science consists in inferring antecedent conditions and anticipating future evolutions from phenomena which have actually come under observation. In biology the difficulties of successfully acting up to this ideal are prodigious. The earnest naturalists of the present day are, however, not appalled by them, and are struggling to pass out of the mere "natural history stage" of their study and to bring zoology within the range of natural philosophy. An ancient speculation, still clung to by many, supposes that, under meteorological conditions different from the present, dead matter may have run together or crystallised or fermented into "germs of life," or "organic cells," or "protoplasm." But science brings a vast mass of inductive evidence against this hypothesis of spontaneous generation, as you have heard from my predecessor in the presidential chair. Careful enough scrutiny has, in every case up to the present day, discovered life as antecedent to life. I am prepared to hear that "our code of biological law is an expression of our ignorance as well as of our knowledge." And I say, let any one who is not satisfied with the purely negative testimony of which we have now so much throw himself into the inquiry.

Such investigations as those of Pasteur, Pouchet, and Bastian are among the most interesting and momentous in the whole range of natural history; and their results, whether positive or negative, must richly reward the most careful and laborious experimenting. I confess to being deeply impressed by the evidence put before us by Professor Huxley, and I am ready to adopt, as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life. How, then, did life originate upon the earth? Did grass and trees and flowers spring into existence, in all the fulness of ripe beauty, by a fiat of Creative Power? or did vegetation, growing up from seed sown, spread and multiply over the

whole surface? Every year thousands, probably millions, of fragments of solid matter fall upon the earth; and it is often assumed that all, and it is certain that some, meteoric stones are fragments which have been broken off from larger masses and launched free into space. It is as sure that collisions must occur between great masses moving through space as it is that ships, steered without intelligence directed to prevent collisions, could not cross and recross the Atlantic for thousands of years without them. Should the time when this earth comes into collision with another body, comparable in dimensions to itself, be when it is still clothed as at present with vegetation, many great and small fragments carrying seed and living plants and animals would undoubtedly be scattered through space. Hence, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present moment no life existed upon this earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation. The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific. From the earth stocked with such vegetation as it could receive meteorically to the earth teeming with the plants and animals which now inhabit it the step is prodigious, and I have always felt that the hypothesis of "the origin of species by natural selection" does not contain the true theory of evolution, if evolution there has been, in biology. Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution, with, however, some reservation in respect to the origin of man, objected to the doctrine of natural selection that it was too like the Laputan method of making books, and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism. I feel convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations.

Reaction against the frivolities of teleology, such as are found, not rarely, in the notes of the learned commentators on *Paley's Natural Theology*, has, I believe, had a temporary effect in turning attention from the solid and irrefragable argument so well put forward in that excellent old book. But overpoweringly strong proofs of intelligent and benevolent design lie all round us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

At the conclusion of the address a vote of thanks to the President was moved by the Lord Justice-General, seconded by Sir Alexander Grant, and carried by acclamation. The President briefly returned thanks, and the proceedings then terminated.—*Times Report.*

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE, ART, AND LITERATURE, 1871.

PROFESSOR AUGUSTUS DE MORGAN. He was educated under private tutors, and in 1824 entered Trinity College, Cambridge, where he took his bachelor's degree as fourth wrangler in 1827. On leaving college he entered himself as a law student at Lincoln's Inn; but he abandoned all thought of following the legal profession on his election, in 1828, to the Professorship of Mathematics in the newly-founded University of London, now known as University College. He resigned his post in 1831, but was re-appointed to it a few years subsequently, on the death of his successor, Professor White, but finally retired from his chair a few years ago. Though well known as a professor, Professor De Morgan's name is even more widely known as a writer on the principles, history, and practical application of mathematical science, and on points connected with the profession of an actuary, which he practised for many years, though not attached to any life office. He also published works on arithmetic, algebra, trigonometry. double algebra, the differential calculus, the calculus of functions, the theory of probabilities, life contingencies, the gnomonic projection, the use of the globes, and formal logic, and a work called the *Book of Almanacs*, by which the reader may turn to the whole almanack of any year, past, present, or future, at once, in either style. Professor De Morgan contributed to Mr. Charles Knight's *Penny Cyclopædia* several of the most important articles on mathematics, physics, astronomy, &c., and also biographies of Newton, Halley, and other men of science to the same publisher's series of *British Worthies*. He was also the author of a series of articles in the *Companion to the Almanac*, 1833–57, and contributed many memoirs and papers to the *Transactions of the Cambridge Philosophical Society*, the *Philosophical Magazine*, and the *Cambridge and Dublin Journal*. He was also a frequent writer in *Notes and Queries*, and in the *Athenæum*. In the pages of the latter, his amusing "Budget of Paradoxes" extended over a series of numbers in the years 1865–66, &c. He was a large contributor to the publications of the Society for the Diffusion of Useful Knowledge. He was also a Fellow of the Royal Astronomical Society, and of the Cambridge Philosophical Society. For upwards of 30 years he was a member of the council of the Astronomical Society, during 18 of which he acted as one of its secretaries. For many years he wrote extensively in favour of the system of Decimal Coinage. He advocated large extensions of the science of logic, and propounded a logical system, of which the most condensed views is to be found in his *Syllabus*, published in 1860.—*Times*.

Sir Francis Crossley, M.P. He was youngest son of the late Mr. John Crossley, who more than half a century since was the founder of the great carpet manufactory at Halifax, which now gives employment to upwards of 3,000 hands. His name, too, is well known in Yorkshire and elsewhere as the munificent co-founder, with his brothers, of an orphanage at Halifax, which bears the family name, and as having been himself the donor to his native borough of a public park, which was laid out by Sir Joseph Paxton with walks, fountains, and marble statuary, at a cost which sounds almost fabulous.

The Rev. Canon Moseley. He some years held the Professorship of Natural Philosophy and Astronomy in King's College, London; and he was one of the first clergymen who were appointed Her Majesty's Inspectors of Schools. In 1853, under Lord Aberdeen's Administration, he was nominated, in reward of his services in the cause of national education, to the canonry now vacant by his decease. The late Canon was the author of many important works, including a *Treatise on the Mechanical Principles of Engineering and Architecture*, which has since been reprinted in Germany and in the United States. He also wrote a *Treatise on Hydrostatics*, &c., and contributed more than one article on applied mathematics to the *Encyclopædia Metropolitana*. Besides these larger and more important works, his active pen found opportunities for contributing a variety of scientific papers to the *Transactions* of the Royal Society, of the Cambridge Philosophical Society, &c. Canon Moseley's name, we may add, was well known in learned circles abroad as well as at home; he was for many years one of the corresponding members of the Institute of France.

Arlès-Dufour, a man of great simplicity and amiability of character. M. Arlès-Dufour, the great silk-merchant of Lyons, was known to many Englishmen by repeated visits to this country, by his ready hospitality to Englishmen in his own home, and by his ardent support of the English alliance and the promotion of peace and intercourse among all nations.

Philip Hardwick, R.A., the son of the architect, a pupil of Sir William Chambers, who built Marylebone Church and Christchurch in that parish. He was also architect of Bethlehem and Bridewell Hospitals, to the former of which he made considerable additions. In 1825 he designed the buildings for the St. Katharine's Dock Company; four years later he designed the new Hall of the Goldsmiths' Company of London. In 1828 he became a Fellow of the Royal Society. The most important works of this architect were the Greek-Doric gateway leading to the Euston Square Terminus, and the new Hall and Library in Lincoln's Inn; the latter, although executed so long ago as 1832, quite in the beginning of the Gothic revival, remains one of the most commendable examples of its class. Mr. P. C. Hardwick, son of

our subject, is reported to have assisted his father in executing this work, if not in designing it.

George Hudson, popularly known as "the Railway King;" his whole career presenting a strange picture of the vicissitudes of the times.

Sir James Pennethorne, architect. The Museum of Economic Geology in Piccadilly is a happy example of his power of design and remarkable talent for ingenious planning and contrivance. The removal of the colonnade from the Quadrant, Regent Street, give him an opportunity for skilfully devising a simple arrangement of balcony, &c., by which a certain dignity and harmony were given to what would otherwise have been a bald and unsightly range of shops. In 1851 he commenced the central section of a design for the General Record Office, to be built on the Rolls estate, and to extend from Chancery Lane to Fetter Lane, the "Central thoroughfare" passing along the north side. The realisation of this design has gradually proceeded, as the necessity for providing adequate accommodation for the records of the kingdom has arisen, and the east wing was completed as recently as last year. At the period of his retirement Mr. Pennethorne had completed the designs for the western block, abutting on Chancery Lane. The State ball-room, supper-room, and galleries forming the south wing of Buckingham Palace were completed in 1854, and subsequently the private chapel of the palace was remodelled. The removal of the Excise Office from Broad Street, and the concentration of the Inland Revenue Department at Somerset House, required that additional accommodation should be there provided; this work was intrusted to Mr. Pennethorne, and in the west wing, facing Lancaster Place, completed 1856, he has faithfully carried out the spirit of the work of Sir William Chambers Additions to the Ordnance Office in Pall Mall, 1852, led to the preparation of designs for a War Office to be built on the site of Buckingham House, Schomburg House, and the adjoining properties. The great competition for public offices, Downing Street, led to this design being laid aside, and the War Office remains located in a range of dwelling-houses converted into offices. The alterations of Marlborough House for the occupation of his Royal Highness the Prince of Wales, and the extensive range of stabling connected with it, were carried out in 1860; and in 1870 his last and greatest work- the University of London, Burlington Gardens—was opened by Her Majesty.—*Builder.*

Lewis Vulliamy, architect.

Richard Bentley, the eminent publisher, of New Burlington Street. In the year 1845, in association with the Hon. Sydney Smythe and the Young England party, he endeavoured to found a newspaper representing their views, and called *Young England.* This attempt, however, did not meet with success. His father was the principal accountant of the Bank of England, and came of an eminent Shropshire family. He was nephew of the well-known antiquary, John Nichols, F.S.A., the author of the

Literary Anecdotes of the 16th and 17th Centuries, and of a *History of Leicestershire.*

Sir Francis Graham Moon, Bart., the eminent print publisher; Lord Mayor 1855-6.

Josiah Parkes, Member of the Institute of Civil Engineers, who, perhaps, more than any other, thoroughly understood the the great question of Drainage. Reasoning from experiments which he made on a Lancashire morass, he was among the first to lay down the grand principles of agricultural drainage which were previously not only unknown but misconceived. The vulgar idea was, and is even yet with educated men who have never thought about the subject, that agricultural land suffers from rain falling on the surface. Mr. Parkes found that a deep drain began to run after wet weather, *not from the water above, but from the water rising from subterranean accumulations below*, and that by drawing the stagnant moisture from 3 or 4 ft. of earth next the surface it was rendered more friable and porous, easier to work, and more easily penetrated by the rain, which carried down air, which is full of ammonia and manure, made it much warmer, and therefore more genial to the roots of the various crops. Without drains a retentive soil is saturated with stagnant water, which remains until evaporated by a warm season, and then leaves the soil hard-baked. Mr. Parkes came to the conclusion that 4 ft., which left a sufficient layer of dry warm surface earth, after allowing for the rise of the moisture by capillary attraction above the water level of the drain, should be the minimum depth. This is now the universally accepted opinion of the best agriculturists in England, France, and Germany. One of the most curious incidents connected with the introduction of the Parkesian or scientific system of deep drainage was the persistent opposition of Baron Liebig, who appeared to allow his anti-English prejudices to interfere with his calmer scientific judgment. The Baron, about the time of the introduction of Mr. Parkes' principles and plans, introduced his patent universal manure, which proved a complete failure. In order to push the sale of the patent manure, Dr. Liebig wrote a letter in its praise, and at the same time solemnly warned English farmers that deep drainage would reduce their lands to permanent sterility, by driving into the drains the principal elements of fertility. It is hardly necessary to say that Baron Liebig has—albeit with a somewhat bad grace—retracted these opinions —*Abridged from the Echo newspaper.*

Crawshay Bailey, the ironmaster, aged 84. He was for many years connected with the ironworks at Nantyglo, Beaufort, Brynmawr, and other places in Monmouthshire; and was related to the first Mr. Crawshay, who, with his successors, have done so much to extend the manufacture of iron in South Wales. Mr. Bailey was also largely interested in the construction of local railways, and, indeed, took part in the promotion of railways both in this country and America.

JOSEPH GILLOTT, the eminent steel pen manufacturer, Edgbaston. He was the first to use machinery for making steel pens. Originally a grinder at Sheffield, his first employment was that of steel toy or tool making. His attention, however, was soon directed to steel pens, which were then made by hand in very limited quantities, at a cost of about 3*s*. 6*d*. each. The present annual production at Mr. Gillott's factory is estimated at 150,000,000 per annum, and the number of workpeople employed 450. Mr. Gillott left behind him one of the finest private galleries in the country, valued at from 80,000*l*. to 100,000*l*., containing many works of Etty, Turner, David Cox, Linnell, David Roberts, Leslie, Ward, Wilkie, Muller, William Hunt, Maclise, Collins, and Frith. Mr. Gillott leaves eight children, who are all arrived at manhood, and a large fortune chiefly invested in land and real estate.—*Times*.

DR. MAYO, the distinguished author of *Elements of the Pathology of the Mind*, and many other important contributions to psychological medicine.

DR. MANSEL, Dean of St. Paul's.

PROFESSOR GEORGE GOTTFFRIED GERVINUS, the eminent historian. The deceased Professor, born in 1805 at Darmstadt, and in 1835 became Professor of History at Gottingen. He first distinguished himself in political life in 1837, by his resistance, in common with Grimm and other professors, to the abrogation of the Hanoverian Constitution by the new King of Hanover (the Duke of Cumberland). He lost his chair, and was compelled to leave the Hanoverian territory—an event which drove him to pursue his studies in Italy. It was not until 1845 that he became Professor of History at Heidelberg His best known works are two volumes of *Essays*; a *History of Literature in Germany*; a work, in three volumes, on *Shakespeare*, and an *Introduction to the History of the Nineteenth Century*, well known in an English translation. In the events of 1848 Gervinus was a prominent actor, being a member of the Frankfort Parliament, and one of those who were commissioned to draw up the new German Constitution, by which the Imperial Crown was offered to the then King of Prussia. When the reaction came Gervinus was tried for high treason, nominally on account of the doctrines contained in his Introduction, but really as the penalty for his share in the revolution, and sentenced to four months' imprisonment. The cause of death was an attack of fever, which lasted scarcely a week, and was followed by paralysis —*Times*.

CIPRIANI POTTER, Principal of the Royal Academy of Music. In 1848 he succeeded Dr. Crotch as Principal of the Royal Academy of Music, and his tenure of that office lasted 20 years, during which time he greatly contributed to the success of the institution. He resigned in 1868, when Dr. (now Sir) Sterndale Bennett was appointed his successor.

SIR THOMAS DEANE, the eminent Irish architect. His name is very widely known in Ireland as having been extensively em-

ployed as an architect for the last 40 or 50 years, by private persons, by municipal authorities, and also by the Irish Government, in many if not most of the various improvements in public buildings, &c., in the south of Ireland, and especially at Cork.

DR. CURSHAM, who for many years, and up to the time of his death, held the appointment of Government Inspector of Provincial Anatomical Schools.

SAMUEL SOLLY, F.R.S., the eminent surgeon. In 1856 he was elected a member of the Council of the College of Surgeons, in 1862 Professor of Human Anatomy and Surgery, and in 1867 a member of the Court of Examiners, becoming also a Senior Vice-President of the College, when an event unprecedented in the annals of the College occurred—he was passed over when his turn came for election into the President's chair, and the choice of the Council fell in 1870 on Sir William Fergusson, Serjeant-Surgeon to the Queen. There is no doubt the disappointment was acutely felt He soon after resigned his chair as a member of the Court of Examiners, retaining only his seat at the Council board. Mr. Solly was deservedly well known from his numerous contributions to the advancement of science, especially by his work on the *Human Brain*, *Surgical Experiences*, an *Analysis of Müller on the Glands*, and by his various papers and lectures on surgery in the medical journals.—*Times*.

M. DUBAN, architect.

ALEXANDER DICK GOUGH, architect, pupil of Benjamin Wyatt, and subsequently entrusted by him with the superintendence of the stone facing of Apsley House, the Duke of York's Column, and other important works.

T. PILGRIM, engineer, who for the last 35 years was intimately associated with Sir F. Pettit Smith, and the introduction of the screw propeller. Mr. Pilgrim acted as chief engineer of the *Archimedes*, celebrated in the history of steam navigation as the first ship ever sent to sea propelled by the screw.

C. H. ADAMS, whose name is well known in connexion with *Adams's Orrery*.

JAMES WHITING, the originator, in 1826, of the *Atlas* newspaper. He died at the age of 94.

LEWIS DOXAT, a very old member of the London press. He was editor of the *Morning Chronicle* in the early part of the present century, when Mr. Perry was its proprietor. Mr. Doxat was for fifty years the editor of the *Observer*. He died at the age of ninety-eight.—*Pall Mall Gazette*.

GEORGE TATE, author of the *History of Alnwick*. and the *Sculptured Rocks of Northumberland*, besides other works, chiefly of geological and philosophical interest. For many years he was one of the honorary secretaries of the Berwickshire Naturalist Club; and the scientific and archæological papers he communicated to this society form a large and valuable portion of its printed proceedings.

J. CLAYDEN, of Littlebury, an active member of the Council

of the Royal Agricultural Society of England, a member of the Council of the Smithfield Club, honorary secretary of the Agricultural Benevolent Association, chairman of the Home Cattle Defence Association, a member of the Central Chamber of Agriculture, a member of the Central Farmers' Club, and chairman of the Islington Agricultural Hall Company. He was also well known in the eastern counties as a breeder of shorthorns and Southdowns, and he was one of the most prominent members of the Essex Agricultural Society. It is only recently that his friend, Mr. S. Jonas, died rather suddenly, and now Mr. Clayden has followed him and another friend, the late Mr. Jonas Webb, to the grave. In November 1869, Mr. Clayden was presented by his friends at a dinner at Saffron Walden with a service of plate of the value of 560*l*.—*Times.*

Alexander Keith Johnston, the eminent geographer. Mr. Keith Johnston's name is best known as having made, on a large scale, the application of physical science to geography. Founding his researches on the writings of Humboldt and Ritter, and aided by the counsel of the former, he produced, in 1848, the *Physical Atlas of Natural Phenomena*, of which more than one edition has subsequently appeared. At different times he was elected an honorary or corresponding member of the principal geographical societies of Europe, Asia, and America; and a Fellowship of the Royal Society of Edinburgh, the University of which city conferred on him the honorary degree of LL.D. in 1865. For the first physical globe he had awarded to him the medal of the Great Exhibition of 1851. Among the best known of Mr. Keith Johnston's other works are his *Dictionary of Geography* (1850), his *Atlas of the Historical Geography of Europe*, his *Atlas of Astronomy*, his *General and Geological Maps of Europe* (1856), his *Atlas of the United States of North America* (1857). To these we must add the series of well-known educational works which bear his name—atlases of physical, general, and classical geography, and, above all, *The Royal Atlas of General Geography*, the only atlas for which a prize medal was awarded at the second Great International Exhibition.—*Times.*

James Easton, the founder, and for nearly forty years the senior partner of the well-known firm of engineers which still bears his name. He was a native of Bradford, near Taunton, and came to London in 1822 to introduce the hydraulic ram, the patent of which he had purchased from the celebrated Montgolfier. In 1825 he was engaged, in conjunction with the late Mr. N. G. Rennie, in a survey of the then projected London and Northern Railway, to which George Stephenson was consulting engineer, and made the Parliamentary plans for the section from London to Peterborough through Cambridge. The scheme, which was most influentially supported by the leading monetary and mercantile men of the day, was carried to Parliament in 1826, but the money panic of that year put a stop to this as well as many other projected railway undertakings. Mr. Easton then

turned his attention to mechanical engineering, and in 1827 established himself at The Grove, Southwark, where the business is still carried on by the present well-known firm. Among a vast number of works he carried out during his long career may be briefly mentioned the perfecting and extensive introduction of the hydraulic ram, the supplying with water of above 30 towns, the Government waterworks at Trafalgar Square, which supply the Palaces and public offices as well as the Houses of Parliament; the improvement of the navigation of the Dartford and Crayford Creeks, and the drainage of the whole of the marshes from London to Dartford on the right bank of the Thames. In Mr. Easton the country has lost one of the pioneers of engineering—one of that band of men who had to devise and inaugurate works with little or no experience to guide them, and prepare the way for the more brilliant but not more solid achievements of modern engineers.—*Times.*

Sir John Frederick William Herschel, Bart., F.R.S., the only son of Sir Frederick William Herschel, the celebrated astronomer, and first President of the Royal Astronomical Society of England. Sir John's first work of note was *A Collection of Examples of the Application of the Calculus to Finite Differences*, published at Cambridge in 1820. As early as 1826 he had received from the Royal Astronomical Society a gold medal for his observations of double stars. In addition to his astronomical work, there appeared by him, in 1830, a *Treatise on Sound*; in 1831, a *Treatise on the Theory of Light*; both published in the *Encyclopædia Metropolitana*; and his celebrated *Preliminary Discourse on the Study of Natural Philosophy*, published in Lardner's "Cyclopædia" in the latter year. In 1836 was published in Lardner a *Treatise on Astronomy*, which proved his power as a popular expositor of the peculiar science of his family. During his well-known absence at the Cape of Good Hope, the Royal Astronomical Society again (in 1836) voted him their gold medal. He was made a baronet on the coronation of the Queen, and a D.C.L of Oxford in 1839. In 1842 he became Lord Rector of Marischal College, Aberdeen, and in 1848 was elected President of the Royal Astronomical Society. In December 1850, when the office of Master of the Mint was made into a permanent one, it was conferred on Sir John Herschel, who retained it until February 1855, when he resigned it on account of ill health, being succeeded by Professor Graham, the eminent chemist. The *Year-Book of Facts*, 1846, contains a portrait of Sir John Herschel, with a memoir.

Charles Babbage, F.R.S., the eminent mathematician and mechanician, also inventor of the Calculating Machine, or more properly, the Difference Engine, which was constructed on essentially the same principles as those on which Pascal's and other machines of the kind were made. He spent on this task a large sum from his private fortune, and received an inadequate grant of public money from the Government. The work was attended

with an expenditure much beyond the original expectation, when Mr. Babbage abandoned the Difference Engine in favour of an Analytical Engine, worked with cards, like the Jacquard loom. But Sir Robert Peel's administration declined to incur further expense in aid of this new and more arduous invention. A dispute ensued with the engineer, who withdrew his tools. Mr. Babbage used to say that he could construct a machine on the principles of his Analytical Engine, which should play and win a game of chess. He was also one of the founders of the Royal Astronomical Society, and of the Statistical Society; also one of the oldest Fellows of the Royal Society. Mr. Babbage died in his eightieth year. A memoir of his life and labours, the latter extending to 80 works, will be found in *The Technical Educator*.

George Grote, the eminent banker. In early life he devoted his leisure hours to the study of the classics; he became a profound Greek scholar, and when quite a young man made it one of the objects of his life to write a History of Greece, which he happily accomplished.

Thomas Brassey, the enterprising railway contractor. To give an idea of the magnitude of the works in which he was engaged, it may be stated that at one time the industrial army set in motion and controlled by Mr. Brassey, amounted to 75,000 men; and his weekly payments must have distributed, as the price of labour, from 15,000*l* to 20,000*l*. every Saturday. The capital involved in the various contracts amounted to some 36,000,000*l* He rose to the unquestioned leadership of his calling. He received distinctions from France, Italy, and Austria; but " no English minister honoured himself by commemorating the great services rendered by Mr. Brassey to his country. As he was only a great industrial benefactor, and not a political partisan or agitator, he was left to the rarer distinction of the respect of all good men The hereditary Order of Knighthood, which owes its origin to the exigencies of the House of Stuart, would have been illustrated by the association of a name that was known wherever industry was active or English spoken. But it would be out of place to expect a Cabinet Minister of the present day to waste honours that might be useful to secure political support, on an independent and non-political man, merely because he was such a one as deserved any distinction that his Sovereign could bestow." (*The Builder*.) Probably, no man in the history of the world, ever at once amassed and deserved so much wealth. His personalty alone, exclusive of his vast landed estates, amounted to 6½ millions Of this gigantic, and during the existence of the court, probably unparalleled sum, 3,000,000*l*. passed to his children in equal shares and the remainder was settled in trust to their equal benefit. These figures are a testimony to the potency of his patience, veracity, and energy.

Robert Chambers, LL D, the presumed author of *Vestiges of Creation*; and editor of *Chambers's Journal*, jointly with his

brother, William Chambers. Dr. R. Chambers was an able geologist, and will be remembered for his researches on "Ancient Sea Margins."

THOMAS BAKER, a self taught mathematician and practical engineer. He was the son of a farmer at Old Park, Durham, and the solution of many of the most difficult problems in the earlier stages of railway surveying and construction was due to his genius. It was he who invented the celebrated method of laying down railway curves, and the *Durham Advertiser* says that he "laid out the Stockton and Darlington Railway, the first line in the kingdom." He also laid out the atmospheric line from Dublin to Kingstown. The last line which he surveyed was that projected by Mr. George Hudson for connecting Lowestoft with London. Mr. Baker was the author of several works on mathematics, theoretical and practical; of these the best known are the *Elements and Practice of Mensuration, a Treatise on Land and Engineering Surveying*, the *Principles and Practice of Statics and Dynamics*, a *Treatise on Subterranean Surveying*, the *Mechanical Companion*, *An Original Method of Integration*, the *Elements of Practical Mechanism and Machine Tools*, and *The Mathematical Theory of the Steam Engine*.

JOSEPH CHESSBOROUGH DYER, a native of Connecticut, and who, shortly after his settlement in Manchester, by the adaptation of several useful American inventions, gave a great impetus to the cotton trade, which was then rapidly developing in that district. Wheeler, in his *History of Manchester*, after speaking of the inventions of the mule and throstle spinning, says:—"Two other important inventions have yet to be named—the fly frame, introduced about 1817, which supersedes the roving frame for middle and lower numbers (of yarns), and the tube frame, which roves much faster than fly, but only for low numbers. Mr. Dyer, of this town, introduced them from America, and in 1825 and 1829 took out patents." So rapidly was the importance of these inventions recognised, that it is said that in a few years nearly 1,000 improved frames were in operation in the mills of the cotton district. Mr. Dyer was the founder of one of the largest firms of machinists in Manchester.

JOHN DECARLE SOWERBY, who, with his cousin, Philip Barnes, F.L.S., laid out that portion of Regent's Park which is now the garden of the Zoological Society. He was well known for his researches upon botany, crustaceans, and other subjects in the Transactions of the Geological, the Linnean, and other leading societies. He occupied the office of secretary to the Royal Botanical Society, Regent's Park, for the unbroken space of twenty-eight years.

THE REV. CANON MORTIMER, who contributed so much, during the twenty-five years of his Head-Mastership at the City of London School, towards the present movement in favour of widening the area of subjects taught in our public schools. Dr. Mortimer is also known as one of the first to show that the "religious difficulty" so often connected with education has been, to say the

least, exaggerated. All denominations of Christians attended the prayers and religious instruction at the City of London School without complaint or ill-feeling, and the exemption of Jews was found to be attended with no inconvenience. This result will not cause surprise now; but twenty-five years ago it was remarkable.—*The Athenæum.*

CAPTAIN J. WOOD, of Highbury. In 1838 Sir Alexander Barnes reported that Lieutenant Wood (why was he only Captain in 1871?) "successfully accomplished his exploration and discovery of the sources of the Oxus." In his march Lieutenant Wood crossed the steppe of Pamir—crossed by the Polos and by poor Benedict Yoes, the Jesuit, "who, seeking Cathay, found Heaven," but (I think) by no European besides. There he found a lake, 15,600 feet above the sea-level, out of which the historic river rises; he called it Victoria Lake."—*The English Churchman.*

GUSTAVE FLOURENS, best known as a Revolutionist; he was also a writer of merit. The son of the well-known Secretary of the Academy of Sciences, he was himself a lecturer at the College of France; and his course on *Ethnography*, delivered in 1863, attracted much attention at the time. His work on *The Science of Man*, published in 1864, was, we believe, his only non-political book; and in 1865 he left France for Crete, where for three years he fought in the mountains against the Turkish troops. Whatever view may be taken of his politics, even his opponents never failed to admit his great courage and perfect honesty.—*The Athenæum.*

AUGUSTUS APPLEGATH, the originator of important improvements in the art of printing; his labours extending over half a century, during which time he took out 18 patents in his own name for improvements in letter-press and silk printing. "Mr. Applegath, like many other inventors, although the pioneer of the fortunes of others, did not reap the reward that might have been expected from his inventive mind. In 1863, writing to the *Stationer*, Mr. Applegath used the following words:—'Before closing this letter, I should be very ungrateful if I omitted to state that though I have not been permitted to do all I wished, yet, through the great liberality of Mr. Walter, a *periodic honorarium* is awarded for my humble attempts to improve the *impressing mechanism* at the *Times*.' The labours of Mr. Applegath may be thus briefly summed up:—In conjunction with his brother-in-law, Mr. Cowper, he produced the machine by which the great bulk of books have been, and are, printed; and to the newspaper reader, who could formerly have obtained a paper printed at the rate of 800 per hour, he offered one printed at the rate of 15,000 per hour, and, had it been necessary, could have greatly increased that rate of production."—*Contribution to the Builder.*

SIR RODERICK IMPEY MURCHISON, Bart., K.C.B., LL.D., D.C.L., F.R.S., &c., the distinguished geographer. (For a portrait and memoir see *Year-Book of Facts*, 1856.) The later years of Sir

Roderick Murchison's life were devoted, like the earlier, to labour and hard work; and the recent Blue-book upon Coal contains the results of much thoughtful study and research by him. It is almost needless to add, that he received recognition of his discoveries in science from the Universities of Oxford, Cambridge, and Dublin, by the bestowal on him of their Honorary Degree; and that he was a member of nearly all the learned societies upon the Continent, including the Imperial Institute of France. He was also one of the Trustees of the British Museum, and Director-General of the Geological Survey of the United Kingdom. In 1863 Sir Roderick Murchison was nominated a Knight Commander of the Order of the Bath (Civil Division), and in the following year he received the prize, named after Baron Cuvier, from the French Institute, and at home the Wollaston medals, in recognition of his contributions to geology as an inductive science. To this it should be added that in 1859 he was rewarded by the Royal Society of Scotland with the first Brisbane gold medal for his scientific classification of the Highland rocks, and for the establishment of the remarkable fact that the cardinal gneiss of the north-west coasts is the oldest rock in the strata of the British Isles. He was created a baronet in January, 1866. His name will long be remembered in the world of science as the author and elaborator of the Silurian system.—*Ibid.*

Émile Hepp, the well-known pharmaceutical chemist of Strasbourg. While labouring to extinguish the fire caused by the Prussian artillery in the civil hospital, on the night of August 25, he received an injury which caused his death after more than five months' suffering, at the early age of 52. The *savants* of Strasbourg all assembled around the grave, and several pronounced short sincere addresses over their friend's remains. M. Hirtz has paid a further tribute to his late colleague by the publication of a careful biography, setting forth Émile Hepp's scientific claims.—*The Athenæum.*

The Rev. Dr. Rock, the ecclesiologist.

The Rev. Dr. Wynter, President of St. John's College, Oxford.

The Rev. Dr. Alford, Dean of Canterbury.

Canon Jelf, of Christ Church, Oxford, formerly Principal of King's College, London.

Canon Melvill, of St. Paul's.

Thomas Ballantyne, long connected with the newspaper press.

Auber, the celebrated French composer.

T. W. Robertson, the popular dramatist.

Dr. Sheridan Muspratt, of the Liverpool College of Chemistry.

Walter Montgomery, the tragedian.

Dr. Henry Hyde Salter, of Charing Cross Hospital.

Joseph J. Skelton, author of *Pietas Oxoniensis, Oxonia Restaurata, &c.*

James Yates, M.A., Highgate, for many years a zealous cultivator of science.

M. Payen, the Professor of Chemistry at the Conservatoire des Arts at Metiers, and a member of the Academy at Paris.

Professor Haidinger, one of the most eminent of our European mineralogists.

George Ticknor, the learned historian of Spanish literature.

Mr. De Wilde, many years editor of *The Northampton Mercury*.

Sampson Low, junior, editor of *The Charities of London*. He was a benevolent and energetic man, and greatly contributed to the successful establishment of the Metropolitan Fire Escape system.

Thomas Roscoe, editor of Lanzi's *History of Italian Painting*.

Mr. Serjeant Woolrych, Q.C., author of *Lives of Eminent Serjeants-at-Law of the English Bar*.

J. H. Robinson, R.A., the famous line engraver.

Mrs. Manning, widow of the Queen's Ancient Serjeant, and author of *Life in Ancient India*.

William Strange, of Paternoster Row, for fifty years a wholesale publisher. He published a satirical journal known as *Figaro in London*, which reached a circulation of 70,000 copies. About the same period Mr. Strange obtained the possession of a rare document which gave in detail the names and amounts of all unclaimed dividends lying at the Bank of England from the year 1802. This document was published under the title of *The Unclaimed Dividends of the Bank of England*. It was issued at the price of 20*s*., and reached a sale of 30,000 copies within two years. In 1848 an injunction was laid against Mr. Strange for publishing copies of the private engravings referred to in a *Descriptive Catalogue of the Royal Victoria and Albert Gallery of Etchings*. It was subsequently found that copies of two engravings had been purloined by one of the workmen employed by a printer at Windsor to take impressions for Her Majesty. On an appeal before the Lord Chancellor the judgment was confirmed. The heavy losses occasioned by this untoward event compelled Mr. Strange to make an arrangement with his creditors. He, however, recovered from the blow by his unwearied perseverance, and was much respected in the Row.—*The Athenæum*.

Appendix.

NATIONALITY OF COPERNICUS.

The approaching 400th anniversary of the birth of Copernicus has revived a contest of long standing between Poland and Germany, each of which claims the astronomer as a son. The Germans argue that he was a German because he was born in Thorn, which at the time of his birth was under German rule; to which the Poles reply that Thorn was then really a Polish town, having been separated from Poland only seven years before; that his father and mother were Poles; that when he studied at Padua he enrolled himself among the students of the Polish nationality; and that throughout his life he gave constant proofs of his attachment to Poland and her king. Poland has always honoured Copernicus as one of her greatest men. A statue of him was erected by national subscription many years ago at Warsaw, and there are two others at Cracow, besides which numerous Polish medals and books have been issued in celebration of his memory. The anniversary above mentioned will be celebrated on February 19, 1873, and great preparations are already being made at Posen for the occasion. The "Society of the Friends of Learning" in the old Polish city held a meeting the other day, at which it was decided, on the motion of a Polish clergyman, Canon Polkowski, to offer a prize for the best life of Copernicus, comprising the results of the latest investigations on the subject, and to publish it in the Polish, French, and German languages.—*Pall Mall Gazette.*

SIR HUMPHRY DAVY.

A project, long discussed, of erecting a statue of this great chemist in Penzance, the town of his birth, is on the point of being realised. A working committee was formed some time since, and by the exertions of its members a sum of 500*l.* has been raised in subscriptions. A very eligible site has been obtained from the Town Council, immediately in front of the Market-house and facing the main entrance of the town. The Messrs. Wills have been commissioned to execute the statue, and they have completed a model of heroic size (about seven feet high), which may be seen at their studio, 172 Euston Road. The statue is designed after Sir Thomas Lawrence's portrait, painted for the Royal Society, and now at Burlington House, but other portraits have been also studied, and the likeness appears to be happy. Sir Humphry is represented in the well-known costume of the period, a light overcoat flung back, with coat within buttoned over, and waistcoat with upright collar appearing above the latter, shorts, long stockings, shoes and buckles; the head is slightly thrown back as if inspired with the courage and enthusiasm for science which excited Coleridge's

strong admiration for his friend; and the right hand rests on a safety-lamp, the product and symbol of the beneficent genius of the chemist. The total cost of the statue and of erecting it on the site provided is estimated at 600*l.*, and it is hoped that subscriptions will not be wanting to make up the small sum still required.

THE RUMFORD MEDAL.

THE American Academy of Arts and Sciences on January 9 presented the American Rumford Medals to Mr. J. Harrison, jun., of Philadelphia, for his invention of safety boilers. The medals are provided for by an endowment fund or gift of 5,000 doll. in the United States Fund, to the Academy, made by Count Rumford in 1796. By the conditions of this endowment the interest of the fund is to be applied "every second year" to the procuring of two medals, one of gold and one of silver, in value equal to the amount of two years' interest of the fund (600 doll.), and these medals (or their equivalent in money) are to be awarded to the author of the most important discovery or useful improvement in the application of heat or light, which shall, in the opinion of the Academy, "tend most to promote the good of mankind." Although the fund was provided at that early day, no discovery or improvement of sufficient importance, in the opinion of the Academy, appeared until 1839, when the first award was made to Dr. Robert Hare, of Philadelphia, for his compound oxy-hydrogen blowpipe and improvements in galvanic apparatus. Since then the awards of the medal have been as follows:—1862, John B. Ericsson, for his caloric engine; 1865, Professor Daniel Treadwell (Harvard College), for improvements in the management of heat; 1867, Alvan Clark, for improvement in lens of refracting telescope; 1870, George H. Corliss, Providence, for improvements in the steam-engine; 1871, Joseph Harrison, jun., Philadelphia, for "the mode of constructing steam boilers invented and perfected by him," which "secures great safety in the use of high-pressure steam, and is, therefore, an important improvement in the application of heat." Mr. Harrison, in acknowledging the award, says: "In what I have done I claim but little merit, beyond having called attention for the last twelve years to the great importance of the question, and in having, in some degree, demonstrated the fact, that a steam generator can be made secure from destructive explosion. I think that this idea has now taken such a firm hold upon the public mind, both in this country and in Europe, that it may be fairly inferred that in the future the use of steam under pressure, no matter what form the apparatus may eventually assume, will not be attended with the disastrous results that are recorded in the past."—*Times.*

THE PRINCIPLE OF LEAST ACTION.

The Rev. Professor Haughton, M.D., F.R.S., has delivered at the Royal Institution, a course of three lectures on the Principle of Least Action in Nature, illustrated by animal mechanics. In his introductory remarks he alluded to the remarkable book on this subject by Borelli, entitled "De Motu Animalium," highly valuable, though full of mistakes, through the author's ignorance of the law of the composition of forces; and to the recent investigations of the brothers Edouard and Wilhelm Weber. He said, there was still a want of some general principle as the foundation for the science of animal mechanics, or the application of geometry and mechanics to animal structures. This, he thought, he had found to be the principle of least action as used in astronomy and physics. After referring to Plato's hypothesis of the construction of the kosmos, or world, with a rational soul, out of chaos, he adverted to the similar notion of Kepler, that the earth has a soul, because it observes the angles made by the heavenly bodies, because it revolves uniformly on an axis, and because it produces crystals which conform to the regular solids of geometry "Earth," he said, "is not a lively animal like a dog, but sluggish, like the ox or the elephant. It moves in the path round the sun that would be voluntarily chosen by a lazy, intelligent animal that wished to accomplish its prescribed task with the least trouble to itself." In illustration of this Dr. Haughton showed that the path of a ray of light through a denser medium than air is the path of least action; and that in organic nature this principle usually takes the form of the production of the least quantity of material necessary to attain a given object. Thus bees construct the largest amount of cell with the least amount of wax; and in like manner the arrangement and mutual position of our own muscular fibres, bones, and joints must be such as to produce the required effect with the least amount of muscular tissue. The Professor then described some of the methods adopted by him, for about twelve years, to obtain the co-efficient of muscular force, by observation of the force of the muscles exerted during life, and by measurement of those muscles after death. This knowledge had been acquired by him with considerable difficulty, and had brought him into familiar intercourse with the Irish sick and poor, at home and in hospitals, and with criminals in prison; and he stated that by the bribe of a little tobacco he had learned the use of burglars' tools, the slate trick, and what is the easiest place (or of least action) on the treadmill. The measurement of the muscles after death was much more difficult, on account of the institution of the "wake;" and the dissection of the body, even of a murderer, was a very perilous operation. The result of his investigations was the determination of the co-efficient of the muscular force of the arm of a young healthy man to be 94·7 lb. per square inch of cross section; of the leg, 110·4 lb.; and of the abdomen, 107 lb.; the mean being 104·03 lb.

Dr. Haughton, in his second lecture, referred to the striking evidence of the greatest amount of power being obtained out of the smallest amount of material, in the cases of those mammals who use their fore limbs solely for locomotive purposes; in those in whom the fore limbs are employed for grasping, climbing, and other purposes; and in ourselves, in whom the hand is placed at the full disposal of the mind. Among them he especially commented on the peculiarities of the eland, tiger, and goat, and the differences in the wrists of the monkeys of the old and new worlds. He then referred to large diagrams, representing the different kinds of muscles—the prismatic, penniform, triangular, quadrilateral, sphincter, skew, and ellipsoidal; and he commented on their combining in their forms great strength with geometrical beauty. As an illustration of the plane quadrilateral muscle, he selected the limbs of the tiger, the most powerful of the carnivora. He stated that when the Bengal tiger and African lion fought in the Roman amphitheatres, the tiger killed the lion; and that when, in the Dublin Zoological Gardens, he had to cut the claws of both animals, eight men were required to hold the tiger during the operation, while five men sufficed for the lion. The tiger, though violent during the process, showed gratitude for the relief derived from it. The cause of the relative strength of the two animals was clearly manifested by comparison of their muscles after death. As another example of the truth of the principle of least action, Dr. Haughton referred to the wings of certain birds. Selecting the albatross, he alluded to the difficulty of obtaining specimens through the superstition of sailors; and he referred to diagrams, the results of long studies of careful anatomical researches; and he commented on the remarkable arrangement by which this interesting bird is enabled to rise slowly from the surface of the ocean to about a thousand feet, and then soar at pleasure without effort—a type of perfection in flying. After noticing several striking peculiarities in the wings of the vulture, he said that the more he had applied the principle of least action to the study of animal structures, the more he had been able to predict its verification, and thereby prove animal mechanics to be one of the exact sciences. "No tentative processes are possible in nature. The planet moves exactly in its proper orbit, and shows no signs of having acquired the power to do so by a succession of less perfect attempts. . . . The socket and axis of the bird's wing are placed exactly in the position best suited to produce the best effect. No tentative process can be found. There is no evidence of birds with less perfect wings, no proof of successive blunders before perfection was obtained. All is perfect, and always was so; no trials, no failures. The graceful limbs of the beautiful tiger and the expanded pinions of the 'sweet albatross' speak to the ear of reason in language that cannot be misunderstood—'The Hand that made us is Divine.'"

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